

THE SPIROPLAY

ARTWORK RE-DESIGN

CREATING APPEALING 2D ART FOR A YOUNG AUDIENCE

Student name: Diana-Valentina Focsaneanu

Student number: 430168

Graduation supervisor: Alejandro Moreno Celleri

Company: The Ambient Intelligence Research Group,

The University of Twente, Deventer Ziekenhuis,

The Medisch Spectrum Twente

Company client: Robby van Delden



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Preface

I would like to thank my client, Robby van Delden, for always giving me feedback, providing me with moral support during this semester and helping me with the testing process and finding participants.

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Abstract

Spiroplay is an application designated for children with asthma that need to perform frequent spirometry tests at home, through mobile-linked spirometers. This application is built for Android tablets that are linked to portable spirometers. The scope is to improve the life quality of children with asthma. Currently, Spiroplay contains minimalistic artwork, so the client would like the assets to be re-worked in an art style that appeals to children between 6-11 years old. Another subject that the client would like to know more about is if age or gender could influence the opinion of the users and if the differences are drastic enough that the audience needs to be split into subgroups.

This thesis will cover the process of finding an art style that is appropriate for the target age group and re-designing the already existing assets. Information about drawing techniques and animation will be gathered through literature study. Multiple potential styles will be created and tested with children from the target audience. Collecting feedback from the children will be done through surveys. The criticism and suggestions extracted from the questionnaires will be used to create a final polished design for the application.

The assets will be integrated into the Unity engine, and possible collaborations with programmers assigned to the Spiroplay team will take place. When certain adjustments are needed, and the student does not possess the technical skill to implement them, the programming team will be requested to assist.

The final product will consist of artwork for the 11 levels in the Spiroplay application. Elements that need to be implemented are:

- Backgrounds
- Main and side character animations
- Particle systems
- Additional decoration elements

Table of contents

Preface	1
Abstract.....	2
1 Glossary	5
2 Introduction.....	6
3 Reason for the assignment.....	7
3.1 Company outline	7
3.2 General description.....	7
4 Objectives of the client.....	8
4.1 Client Question	8
4.2 Product/Services needed	8
4.3 Limitations.....	9
5 Problem analysis.....	10
6 Theory.....	10
6.1 Serious games	11
6.2 Environment design	11
6.3 Character design	13
6.4 Common cartoon elements	14
6.5 Color theory	15
6.6 Animation.....	16
6.7 Applying the knowledge gained through research	17
7 Problem definition.....	19
8 Main and Sub Questions.....	19
9 Scope	20
10 Methods	21
11 Analyzing the Unity project	22
12 Implementation of the art style	24
12.1 Cartoon researching.....	24
12.2 Cartoon art survey	24
12.3 Product Design	27

13	Potential art styles.....	28
14	Final art style survey.....	31
15	The final product	33
15.1	The final environment style	33
15.2	The final character style.....	35
15.3	Animations	37
15.4	Final levels.....	38
15.5	Menu re-design	40
16	Testing the final product	41
17	Polishing the product	43
18	Results	44
19	Discussion	45
19.1	Testing: The three surveys.....	45
19.2	Unity limitations.....	45
20	Recommendations.....	46
20.1	Play-testing and Interviews.....	46
20.2	Audio improvement	46
20.3	Marketing the product.....	46
21	Conclusion	47
	Appendices	48
	Bibliography	56

1 Glossary

2D animation: The art of creating movement in a two-dimensional space. (Stefyn, 2019)

3D animation: The art of using motion to bring characters, vehicles, props, and more to life within TV shows, films, and games in a three-dimensional space. (Fitzgerald, What Is 3D Animation?, 2018)

Concept art: Concept art is a visual representation which tells a story or conveys a certain look. (Fitzgerald, 2019)

Unity: A popular engine used for creating 2D and 3D games. (Petty, n/d)

Adobe Photoshop: A software that is extensively used for image editing, graphic design and digital art. (Techopedia, n/d)

Framerate: Framerate, also known as frames per second, is a term used to describe the number of individual images that a video or game displays on screen in during a single second. (Harper, 2017)

2 Introduction

According to Boeschoten, et al. (2018), asthma is the most widespread chronic disease of childhood in The Netherlands, affecting 5-10% of children up to the age of 12. This condition has a negative impact on the living standards of those affected by it and their families.

Gallucci (2019) states that asthma monitoring is an essential step in managing this condition because it can prevent serious exacerbations and poor lung function. The spirometry is the main test for detecting and measuring airway obstruction in children over the age of 5 and it can predict future asthma attacks. Johnston (n/d) mentions that spirometry is usually performed at the hospital, but some cases require frequent monitoring. Portable mobile-linked spirometers allow the patients to do this process at home, decreasing the need to travel. Some spirometers can electronically transmit the results registered from the test to the hospital.

A study performed by Wensley and Silverman (2001) reveals that when performing the spirometry test at home, the compliance of the users deteriorated over time. The lack of compliance leads to a steady decline in the valid data obtained from the procedures.

To address the issues of home spirometry, a consortium composed of The University of Twente, Saxion University of Applied Sciences, Medisch Spectrum Twente and Deventer Ziekenhuis developed a project proposal for an application that integrates gamification in the spirometry process. This application is meant to motivate the users to perform the spirometry test properly, thus reducing the invalid data caused by the lack of compliance. The collaboration between these four medical and educational institutes has been made based on the common goal of increasing the living standards of children that are affected by asthma.

3 Reason for the assignment

3.1 Company outline

The Ambient Intelligence research group at Saxion University of Applied Sciences is a research group that focuses on applications related to safety, sports and the smart industry. This assembly makes it possible for students, teachers, researchers and companies to collaborate in a project. The Medisch Spectrum Twente and Deventer Ziekenhuis are two hospitals in the Overijssel region of The Netherlands. Within these institutions, the pediatric departments are performing spirometry sessions with children that suffer from asthma.

The University of Twente and Saxion University of Applied Sciences are working together on developing a Unity application for mobile-linked spirometers called Spiroplay. These two parties are concerned with the development of the project both programming-wise and art-wise. A programming team and a 2D artist have been assigned to work on this project so far. Regarding the testing sessions and providing information about the target audience, the Deventer Ziekenhuis and Medisch Spectrum Twente are involved as well. These parties are working separately but will collaborate with the student on several aspects of the application.

3.2 General description

During the spirometry test, the patient must inhale and exhale into the spirometer device multiple times. The goal of this Unity project is to make the spirometry process enjoyable and encourage the users to perform as well as they can without losing interest or motivation. So far, a prototype built for Android tablets has been developed. When the spirometer device is used, the inhaling and exhaling data is registered on the Android tablet. The application contains multiple levels that represent breathing metaphors, such as blowing the petals off a flower. These metaphors are meant to offer visual feedback to the user, such as playing suggestive animations when the peak flow is reached. The levels have been designed with the help of medical experts and the target audience, which is children between 6-11 years old. The Spiroplay application contains 11 breathing metaphors:

- A car being powered
- A bowling ball being thrown
- A dog being groomed
- Flower petals being blown
- Catching fish in a net
- Water tides revealing a treasure chest
- A dragon blowing flames
- Balloons being hit by an arrow
- A swimmer jumping in the water

- A football being kicked
- An athlete running

Before the start of this graduation assignment, a set of minimalistic 2D assets has been created for each metaphor, as well as the UI. The already existing artwork can be observed in the in-game screenshots included in Figure 1.

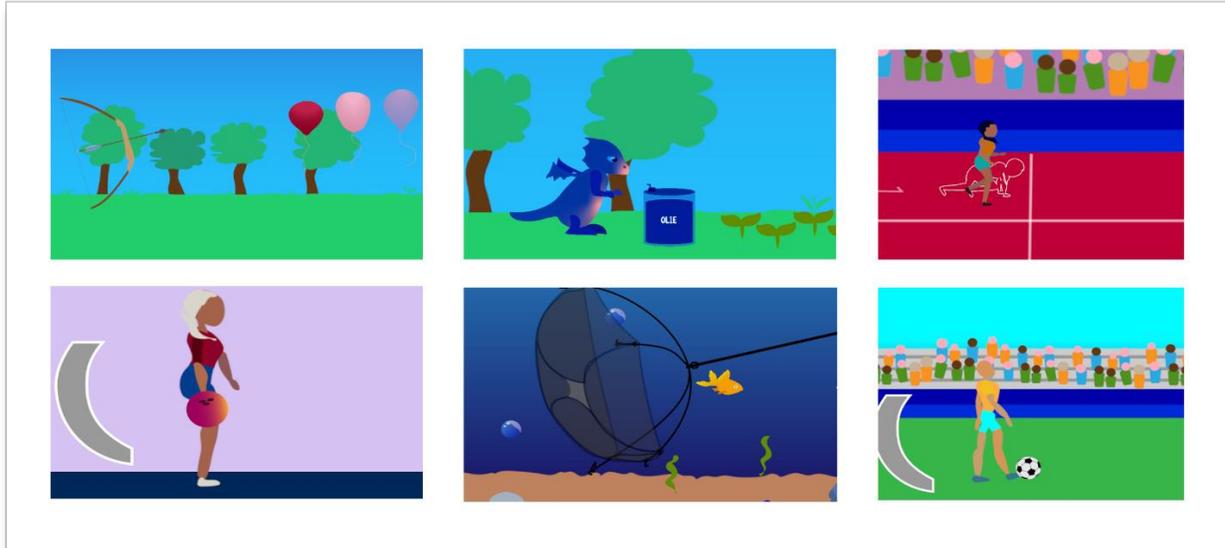


Figure 1 Already existing artwork in the Spiroplay serious game

4 Objectives of the client

4.1 Client Question

The client wants to know what kind of art styles appeal to children in the target audience and how the already existing assets would look like if they were recreated in a new and more complex art style. After the assets are re-designed in multiple styles, a testing session with the children will determine which aesthetic is the most appealing. The UI will be re-created in the same style as the final art style is chosen so that all the visuals in the application look consistent.

4.2 Product/Services needed

In order to re-design the 2D assets in an art style that appeals to children, the student must find out which art styles are suitable for them. The research could be conducted using the desk or field research method.

During this stage, a survey or interview will be made and filled in by the children or their parents. The survey will include images that contain different styles, both 2D and 3D, and the audience can select which ones they prefer.

After the research stage, the student will create multiple sets of 2D or 3D game-ready assets that will be inspired by the most preferred images of the survey. Depending on the results of the survey, elements such as shapes, line-art and color schemes from different images could be combined, and a new style could be created. The assets will be implemented in the Unity application, followed by a testing session with the target audience. The objective of this testing session is to select one aesthetic that appeals to the audience the most and re-create all the assets in that specific art style.

4.3 Limitations

A challenge encountered in this project is the technical limitation brought by the Unity application. Android does not support heavy applications, and the game will be played on an Android tablet connected to the Spirometer. If the game has lagging problems, there is a risk of it becoming less enjoyable. In order to avoid this issue, it is recommended to avoid having animations that contain too many frames. Another measure that could prevent the performance issue would be to keep the 2D assets at a relatively small size. A size limit could be imposed from the beginning, for example, no asset would have a larger resolution than 512x512 pixels per inch, with a maximum dot density of 72 dots per inch(dpi). The software that will be used in order to create the 2D assets is Adobe Photoshop, because it is a simple tool to use, and it allows the user to create both the illustrations and the animations. The desired size can be set up at the beginning of a Photoshop project, and it is also possible to adjust this aspect later in the project.

Another limitation is brought by the available time for this graduation project. Within a five-month timeframe, the student must research and create assets based on the research results. Both processes require plenty of time and attention and testing. A right approach is to set up time limits for each task in order to be able to complete the goals set up in the beginning. The planning must have an efficient structure that also allows the student to assign hours into polishing the product.

5 Problem analysis

The current art style in the game does not satisfy the client's needs because of the simplicity of it and the slight lack of consistency. Although the current artwork is too minimalistic, it serves as a good base for further improving the quality of the visuals. Observing the already existing animations is the right way of establishing technical limitations from an early stage.

The decision of re-designing the existing assets in different art styles could influence the children's opinion on the Spirometry exam. At first, the client was interested in mainly 2D artwork because that is how the subject of visuals has been approached in the early stage of development. However, if the research results will show that the children prefer 3D artwork over 2D artwork, then the assets will be re-designed in a 3D technique. During the research stage, both 2D and 3D art styles will be taken into consideration. When performing an interview session with the target audience, images of both types will be shown, so they will have the option to choose the style that appeals to them.

Another fact that could influence the results and plan of approach is the broad age group of the target audience. Some younger children might prefer a particular art style and older children might be attracted to a different aesthetic. A possible approach would be splitting the target age group into multiple subgroups and create different levels for them. This way, the game will contain levels that appeal to various subgroups in the target audience.

6 Theory

This chapter contains information relevant to the context of this assignment and the work to be done. This application is aiming to streamline the process of at-home spirometry for children suffering from asthma. Therefore, this application can be categorized as a serious game, and this topic will be researched in more detail. Another step would be to study about different art styles, character creation, environment creation, color theory and animation. These topics could help increase the student's current skills and improve the quality of the final product. Prototype illustrations and animations will be created with the purpose of gaining experience by applying the knowledge gathered.

6.1 Serious games

There are multiple definitions of what a Serious game is. However, most of them state that a Serious game's purpose is not pure entertainment. (Growthengineering, 2016)

According to Designing Digitally (2018), there are three different purposes of Serious or Applied games:

- Education: Adding an element of fun in a learning experience in order to keep the user engaged;
- Persuasion: Leading the learner towards a conclusion and teaching critical thinking skills;
- Health: Motivating users with a disability/condition by offering positive feedback or rewards;

Schell (2015) mentions that Serious games can have several positive effects on users. Emotional maintenance is an example of the positive effects attributed to games because it helps the player to build confidence, relax, cheer up, or gain perspective.

Regarding the topic of children's games, Schell (2008) analyses the preferences of different age groups, while also taking the gender factor into account. Children between the ages of 7-9 are usually able to read, think about their decisions and solve problems. Their interest in games increases and they become aware of what kind of things they enjoy or dislike. The preferences of this age group are no longer heavily influenced by their parent's choices. Gender plays a role in influencing the user's inclinations because males and females have different interests, skills and abilities. It is stated that female players learn better by example and prefer having a clear tutorial. A game can appeal to both sexes if there is a variety of experiences.

6.2 Environment design

When creating environmental concept art, Walid Feghali (n/d) suggests that a good starting point is a technique called thumbnailing. Thumbnailing consists of creating a grid of 3x3 rectangles and sketching different environment ideas in them. In these sketches, the artist would use different levels of grey to add dimension to the image. This method allows the artist to focus mostly on composition at first, and later detailing and color palette. Feghali provides examples of how to use white, grey and black to add dimension to the environment. This can be seen in Figure 2. After thumbnailing, the artist can choose the most appealing sketch and refine it. This includes adding color, detail and more volume to the image. Different types of brushes can be mixed to add different textures to the elements in the painting.



Figure 2 Environment design process, adapted from PAINTING ENVIRONMENT CONCEPTS IN NO TIME, by W. Feghali, retrieved from: <https://www.evenant.com/design/painting-environments-in-no-time>

Robert Laszlo Kiss (2020) explains in his video tutorial the basics of integrating perspective into one's environment drawing. He describes two types of perspective that can be used to add volume to an illustration:

- Aerial perspective implies accentuating the objects that are closer in an image, while objects that are placed at a greater distance won't have the same amount of detail.
- Linear perspective means using one, two or three vanishing points to guide the lines of a drawing. Using linear perspective can make the objects that are placed closer seem more massive than the ones behind them.

Richard (2020) states that using a 3D base for an illustration became a standard procedure in the concept art production pipeline. Using a 3D base provides accurate information about perspective, scale and lighting. He suggests that the sky of an environment should match the rest of the image, meaning that it needs a similar color and tone. Richard (2020) also warns that having too many vertical and horizontal lines can make an image seem dull, so he advises to include curves and diagonal lines to make it less bland. In order to hide the very sharp edges of a 3D model, stylized brush strokes can be used. This can make the product look more like an illustration and less like a render.

Tinelli (2019) explains that The Golden Ratio and The Rule of Thirds are two commonly used tools for achieving balance in a composition. They can be used to direct a viewer's attention to a focal point. These tools are can be used in photography and painting. Examples of The Golden Ratio and The Rule of Thirds can be observed in Figure 3.

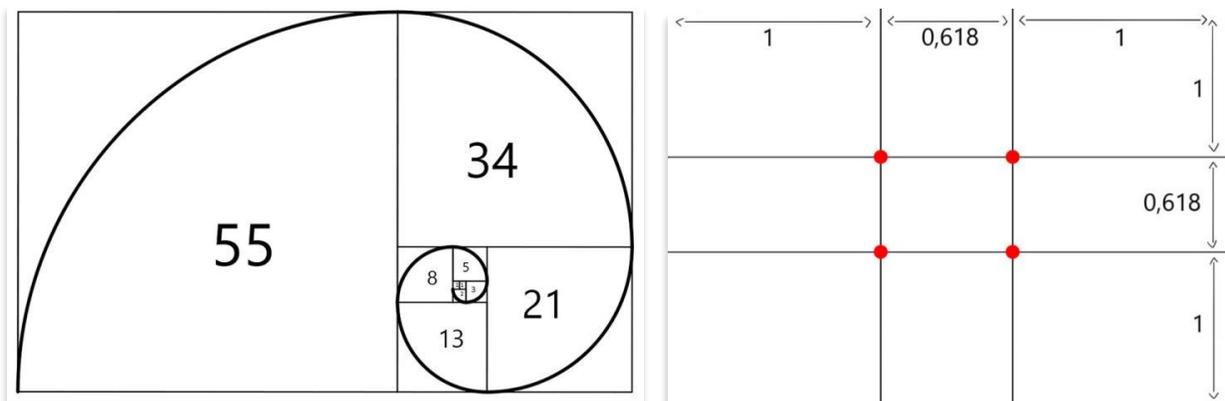


Figure 3 The Golden Ratio and The Rule of thirds. Nicholas Tinelli.2019. Adapted from The Golden Ratio: origin of the Rule of Thirds, retrieved from <https://nicholastinelli.com/the-golden-ratio-origin-of-the-rule-of-thirds/>

6.3 Character design

According to Mitch Leeuwe (2019), when creating a character, it is essential to think about the construction of the character. Elements such as geometric shapes integrated into the design, along with the use of the lines of action are used to enhance a character's personality. The three basic 3D shapes that are used in a character's design are the cube, sphere and cylinder. Using sharp angles can make a character seem more serious or even dangerous, while rounded shapes tend to give an innocent look. These shapes can be attached to the line of action and combined in such a way that a simple character block is created.

Starting with a silhouette is the right way of experimenting with an abstract shape as the base of a character. The silhouette needs to be clear and recognizable, so the gender, age and other aspects of a character would be easy to read. The most popular cartoon characters have a silhouette that can be recognized easily. The artist can add on to a silhouette by adding lines, more detail and shading. This process is shown in Figure 4.

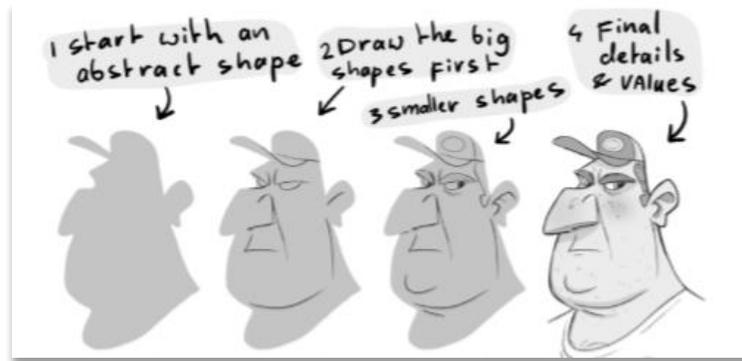


Figure 4 Character design process, adapted from *How to draw characters* (page 35), by M. Leeuwe, 2019

Leeuwe also states that another tip that can be followed when creating a character is following reference from real life, such as everyday objects or even a skeleton. The skeleton shape can be exaggerated or simplified and used as a base for the character's pose and body shape. Having contrast in the proportions is a way of making a sketch or silhouette more appealing to the viewer.

The author states that there are 5 different body types that can be observed in humans. These body types are the following:

1. Regular
2. Long
3. Round
4. Heavy
5. Strong

Age is another element that influences a character's physical aspect. An example would be the difference between an infant's body shape, compared to an adult. Children are considered cute because of their contrasting body features. The head, eyes and forehead are larger, the overall body shape is chubbier, but

some features are small-sized, like the nose and mouth. An adult's features are equal and balanced, but as they get older, they tend to gain weight, have a gravity influenced posture and larger noses and ears.

Designing a character with personality requires a few factors to be considered before drawing. Jenny Harder (2020) explains that an artist needs to research what can be done in the time available for the target platform and style. For a computer game, the character needs to be functional, which means that the silhouette needs to be easy to read. In a game, the character might be tiny on the screen, which is why it needs to be recognizable from a distance.

6.4 Common cartoon elements

To find out what are the most common elements used when creating art for a young target audience, several cartoon examples have been analyzed. It was concluded that multiple cartoonists used similar methods and features when creating their character and environment concepts. Figure 5 shows the similarities between four cartoon styles that have different aesthetics, yet noticeable common elements.

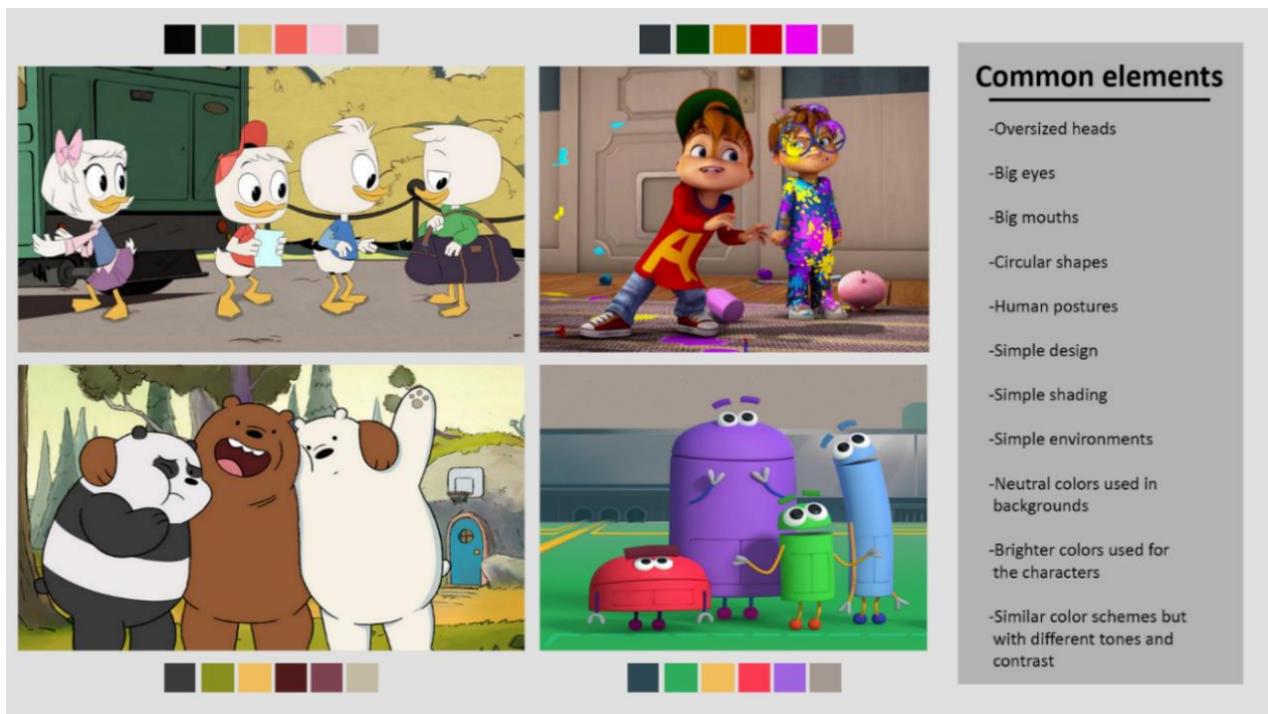


Figure 5 The common elements found in multiple cartoons.

6.5 Color theory

The colors used in an environment or character's design can have an impact on the viewer. It is stated by Cameron Chapman (2010), that warm colors are energizing, while cold colors are more relaxing. Colors can be associated with different feelings which can differ depending on some cultures. Red is a color that tends to be associated with danger, violence or even love, but also captivates attention. Yellow is generally associated with happiness and hope, and even courage in some cultures. Blue can represent sadness but also peace and calmness. Neutral colors such as grey or beige work very well when combined with brighter colors or tones. Pure black is associated with power, elegance and formality while white is associated with purity and cleanliness.

Sandoche Additane (2017) mentions a few color combinations rules that can be followed when establishing a color palette at the beginning of a project. There are multiple methods of creating color schemes, but the ones that are showcased in Figure 6 are simple and easy to follow.

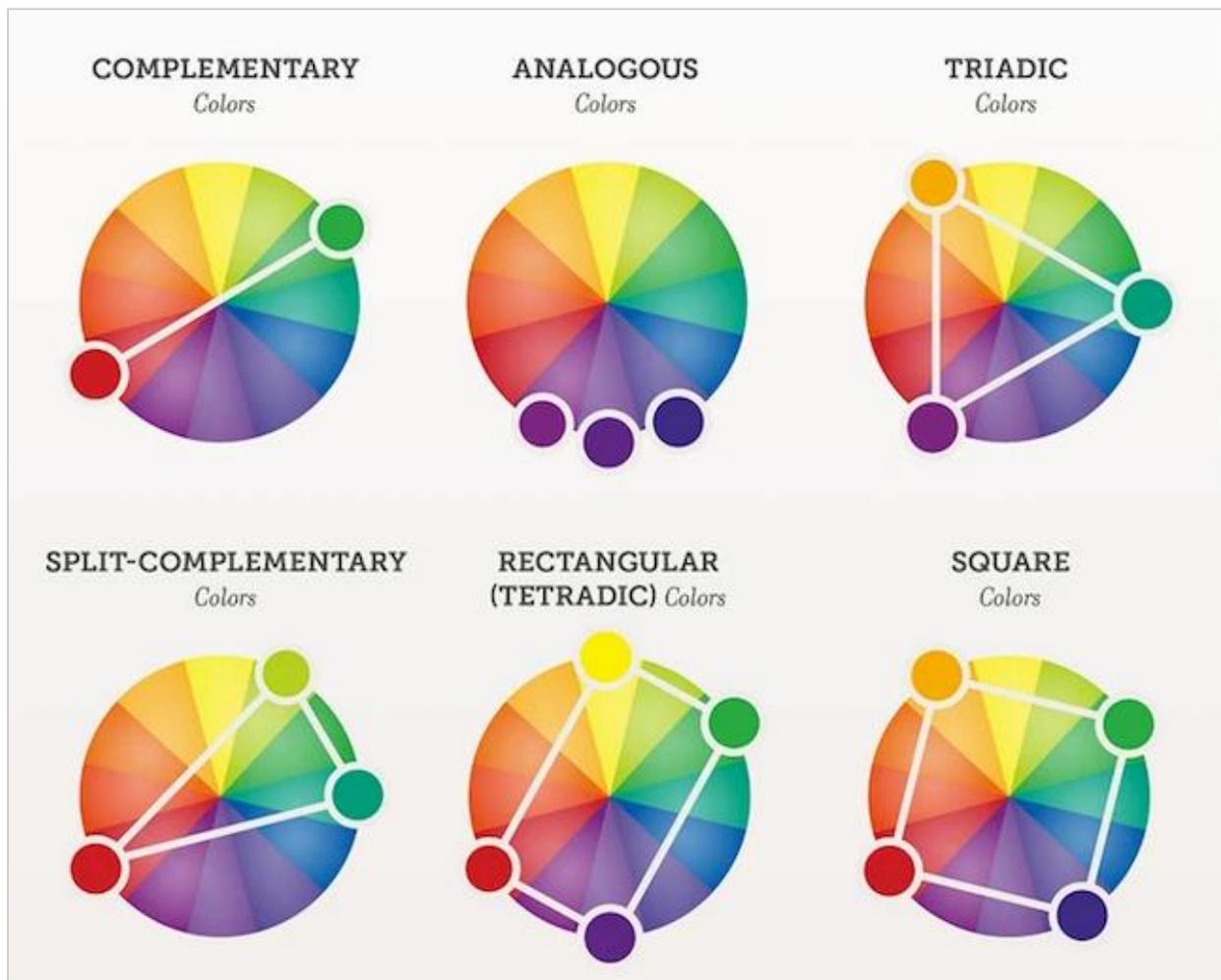


Figure 6 Color scheme types, adapted from Shopify, by H. Khan, 2018, retrieved from:

<https://www.shopify.com/retail/store-signs-and-red-signs>

6.6 Animation

2D animation is a form of art that creates movement in a two-dimensional space, and it includes characters, backgrounds or special effects. The illusion of movement is created by sequencing individual drawings over time. Different frame rates could be used for one animation, depending on the time or technical limitations. For one second of animation, the frame rate can vary from 2 frames to 24 frames. Although 2D animation started as traditional art (drawn on paper), nowadays it could be created digitally using a range of software¹. 2D animation is used in creating television series, movies, video games or advertisements. (Stefyn, What Is 2D Animation? Everything You Need To Know, 2019) The 12 Fundamental Principles of Animation (Thomas & Johnston, 1981) are techniques that can be used when creating a character in motion. These principles of animation and their explanations can be observed below.

1. **Squash and stretch** - Expanding and compressing the character's body
2. **Anticipation** - Adding a small animation of a body or face movement before something major is about to happen
3. **Staging** - Using frames with precise poses, showing the attitude and movement of the character
4. **Straight Ahead Action and Pose to Pose** - The techniques by which the animations are crafted: the first one involves drawing the key poses followed by filling in the transitions; the second one consists in making a draft scene by creating one frame after another
5. **Follow Through and Overlapping Action** - When a character stops moving, elements such as the hair continue moving for a short time
6. **Slow in and Slow out** - Creating more frames in the beginning and end of the animation, and fewer frames in the middle
7. **Arc** - All the animated actions have a slight curve to the movement
8. **Secondary Action** - Used to add more dimension to a character that performs an action by animating a secondary action
9. **Timing** - Using the number of frames to make the scene faster or slower
10. **Exaggeration** - Exaggerating an expression or movement to make a scene more convincing
11. **Solid Drawing** - Making a drawing seem three-dimensional by adding volume and weight to the characters
12. **Appeal** - Creating a pleasing design for the character or adding interesting personality traits, making it attractive to the viewer

¹ Examples of such software are Toon Boom Harmony, Adobe After Effects and Adobe Photoshop.

6.7 Applying the knowledge gained through research

Applying the theory gathered in Chapter 6, Sections 6.2 and 6.3 by creating prototype environments and characters is a step that was meant to help improve the current artistic skills of the student.

The closest buildings are more detailed and accentuated than the ones behind. The sky has a light blue color with a cold tone. The fog has been used to blend the sky into the image, thus adding more volume. In Figure 7, it can be observed how using a 3D base render helped in creating a city environment.

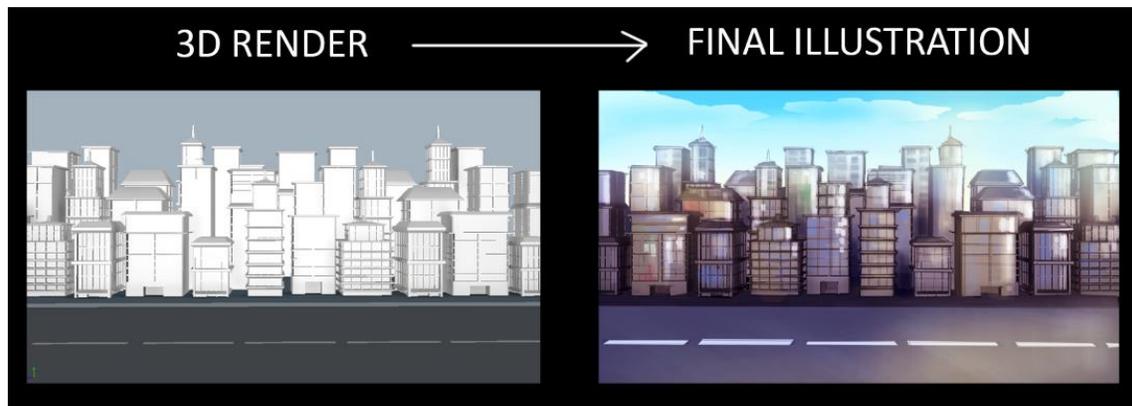


Figure 7 Self-made 3D models and illustration of an urban environment

The student felt the need to study some of the subjects and make rough sketches before creating these prototypes. Different types of dogs and dragons have been drawn with the purpose of getting familiar with the anatomy of these characters. These sketches can be found in Figures 8 and 9.



Figure 8 Character re-design silhouettes and sketches

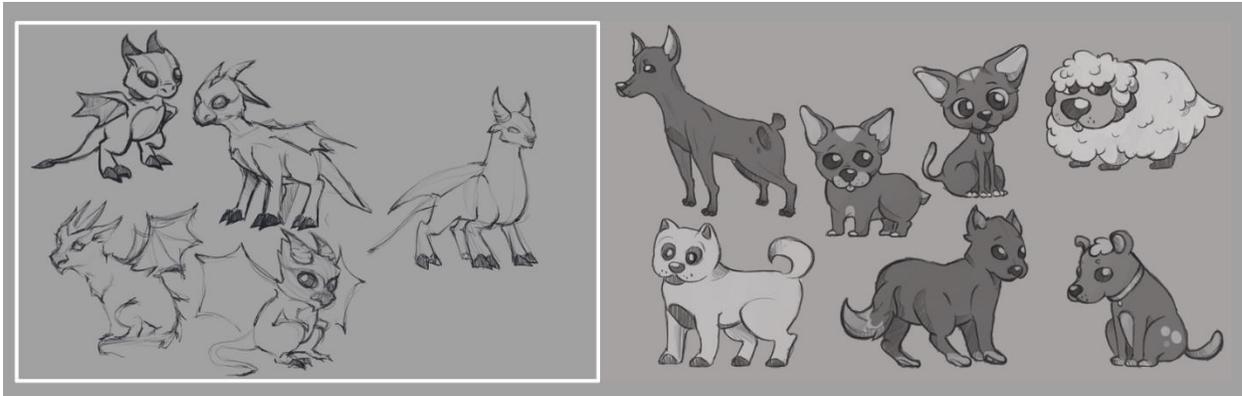


Figure 9 Sketching exercise with dragon and dog subjects

To exercise the animation skills, the student created a prototype version of the dragon level from the SpiroPlay application. The prototype can be seen in Figure 10. Practicing this helped establish how much time should be assigned for the final animations. The colors used in this animation are complementary. The bright red shades of the dragon stand out from the light green hues of the forest environment. An approximate of 3-4 days of work is required to create one level, with the character animation and setting included. Things that can be improved in the animation have been discovered as well, after analyzing the outcome with the client. For example, the character's movement needs to be more exaggerated, the oil bucket needs to be visibly emptied, which implies making it transparent, and the fire could be larger and more dramatic.



Figure 10 Frames of the animation practicing outcome

7 Problem definition

In order to satisfy the client's needs, the art style of the metaphors in the SpiroPlay application must be improved and become more appealing to the target audience. Information gathered and displayed in Chapter 6 can be used in the process of creating new assets for the 11 metaphors. Regardless if these assets will be 2D or 3D, the knowledge acquired about drawing and animation theory can still be utilized.

The subjects that need to be researched in order to create a final product that satisfies the client's needs are:

- The target audience's preference of art styles and if gender or age subgroups influence the opinions;
- Creating game-ready assets that do not cause performance issues in the Unity application;
- Different sources of art style inspiration like animated series or movies;

For the final product to appeal to the target audience, it must meet the following criteria:

- Consistent art style for both the characters and environment with an easy to follow color palette;
- Appealing characters or object design with recognizable silhouettes and contrasting body shapes;
- Animations that follow the 12 Fundamental Principles of Animation described in the previous chapter;

8 Main and Sub Questions

Based on the Problem definition elaborated in the previous chapter, the main research question has been established:

"How to re-design multiple sets of 2D or 3D game-ready assets for the Spiroplay Unity serious game in an art style suitable for children between 6-11 years that suffer from asthma?"

In order to tackle the main research question, the problem has been divided into multiple sub-topics:

1. How to create an art style that appeals to the young target audience?
2. Is age a factor that could influence the target audience's view on the art style?
3. Is gender a factor that could influence the target audience's view on the art style?
4. How to create optimized assets that do not cause performance issues in the game?

9 Scope

The final product is supposed to make the Spiroplay application look polished and captivating. The main goal of the serious game is to increase the life quality of the users. However, the artwork is just an element of the game that cannot completely change the perspective of the user. The time limit will not allow for the graduate student to observe if the life quality of the target audience increases over time with the application improvement.

UI is an art element that must be consistent with the style of the game, but depending on the time available, the student might not be able to re-design all the UI assets. Because it is still desired to improve the UI artwork as well, multiple elements can be recycled or enhanced. For example, the color scheme can change, patterns can be added, and small changes to the shapes can be made.

A subject that the student will not approach in this project is the technical part. In order to prevent the game from having performance issues, the technical boundaries won't be crossed, but the student will not add programming changes. The final assets will have a small resolution and number of frames.

Not all the TV channels and cartoons for children will be researched, but only the newest, most popular ones. Animated series that have been released more recently might be recognized more easily by the children than old, classic ones.

Sergey Korolev (2019) suggests using the MoSCoW method to create a prioritized list of requirements. The application of this method can be seen in Table 1.

Must have	11 sets of 2D assets for the metaphors.	2D assets that do not exceed the technical limitations.	UI that matches the color palette in the application.
Should have	Changes to the already existing concept of the character. Ex: making the character into a different species, different age.	Changes to the initial environment objects/positioning to improve the composition.	Particle systems created in Unity that make the levels more dynamic. Ex: Leaves flying in the background, butterflies or sparkles.
Could have	Complete re-design of the UI in a different, more elaborate style.		
Won't have	Programming related changes.	Game design changes.	

Table 1 List of requirements created using the MoSCoW method

10 Methods

To answer the sub-question formulated in the previous chapter, desk and field research needs to be done. According to CMD (Communication and Multimedia Design) Methods (2015), there are multiple strategies for researching a subject. The student chose several research methods to apply in this process of answering the questions.

1. How to create an art style that appeals to the young target audience?

To ensure that the product will attract the target audience, the student will research trending cartoons that are broadcasted on tv or streaming platforms. Following this step, the student will start organizing an interview session where children can share their opinions on their preferred animated series. After gathering enough information about this topic, the student will proceed to create an art style by combining elements from multiple popular animated series.

2. Is age a factor that could influence the target audience's opinion on the art style?

This question will be answered after organizing interviews and play-testing sessions with the target audience. The age of the users will be written down, so, at a later point, the student can observe if age is a factor that makes a difference in the children's opinion. Another way of gathering useful information about this topic is to have an Expert Interview session with someone that has experienced working with children or creating artwork for a young target audience.

3. Is gender a factor that could influence the target audience's opinion on the art style?

This sub-question will be answered through the same process used in the previous one. The interview and testing sessions with children could provide the necessary information required to answer this question.

4. How to create optimized assets that do not cause performance issues in the game?

Creating optimized assets for the Spiroplay requires analyzing the Unity project in order to set up the technical boundaries. The student must observe the already existing assets in the application. Their resolution and number of frames are the two factors that need to be considered when establishing the limitations. Once the project has been studied, the next step will be creating assets that fit within the boundaries.

11 Analyzing the Unity project

In order to find out how to create optimized assets for the game, the student was provided with a Unity file that contained the Spiroplay project in progress. Eight levels were already implemented in the application. These levels were functional and had the minimalistic assets integrated. This file was used to observe how the levels worked, how the assets were implemented and what size has been used for them.



Figure 11 Unity game engine project menu

The animations in the engine were created and implemented frame by frame. One jumping animation contains 138 frames. The maximum size set for each of these frames is 256x256 pixels. These limits will not be exceeded by the student when creating new animations.

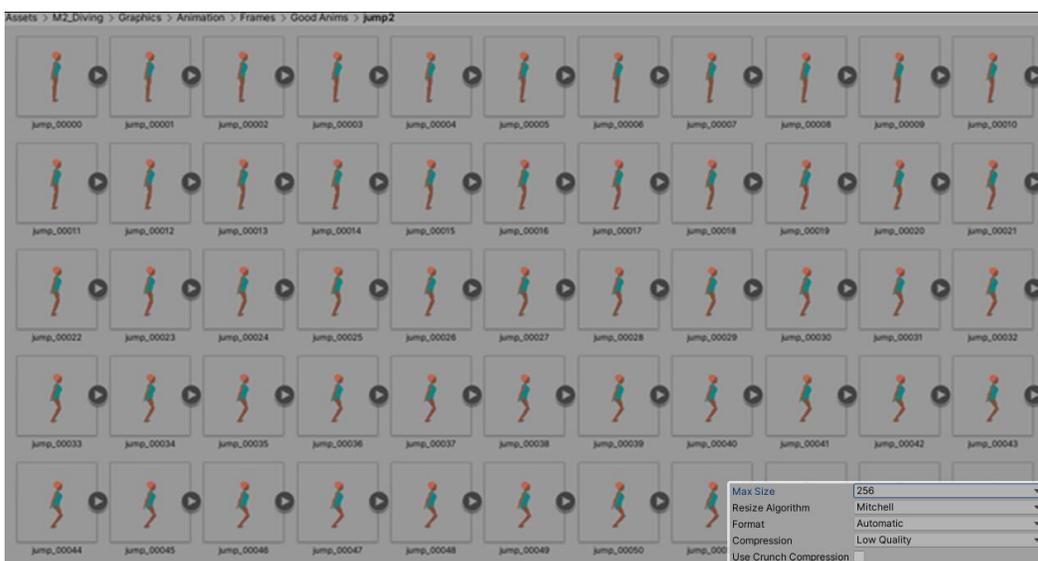


Figure 12 Current jumping animation frames in Unity and its size

The current city environment in the app is set to a maximum resolution of 4096 pixels. It is possible, however, to re-create this environment with a resolution of 2048 pixels.

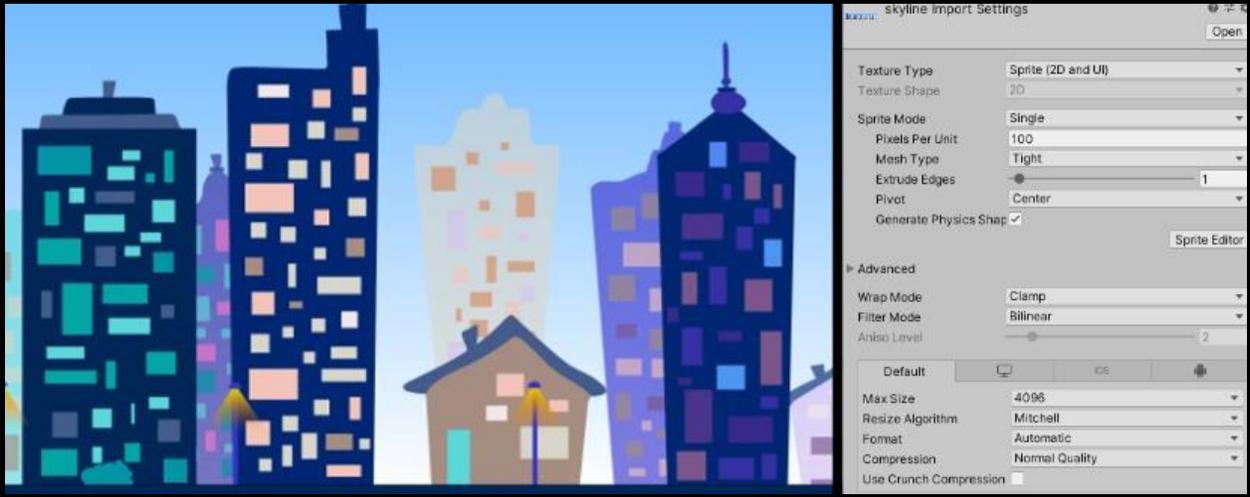


Figure 13 Current urban landscape in Unity and its specifications

A crucial aspect that needs to be considered is the transition between the animation states. A walking animation cycle is separate from a jumping one, and the connection between these two is made in the engine editor. Currently, there is no visual transition between the animation states, which makes the overall movement flow seem unnatural. The student will attempt to make a smooth transition by making sure that the animations start and end with the same frame where it's necessary.

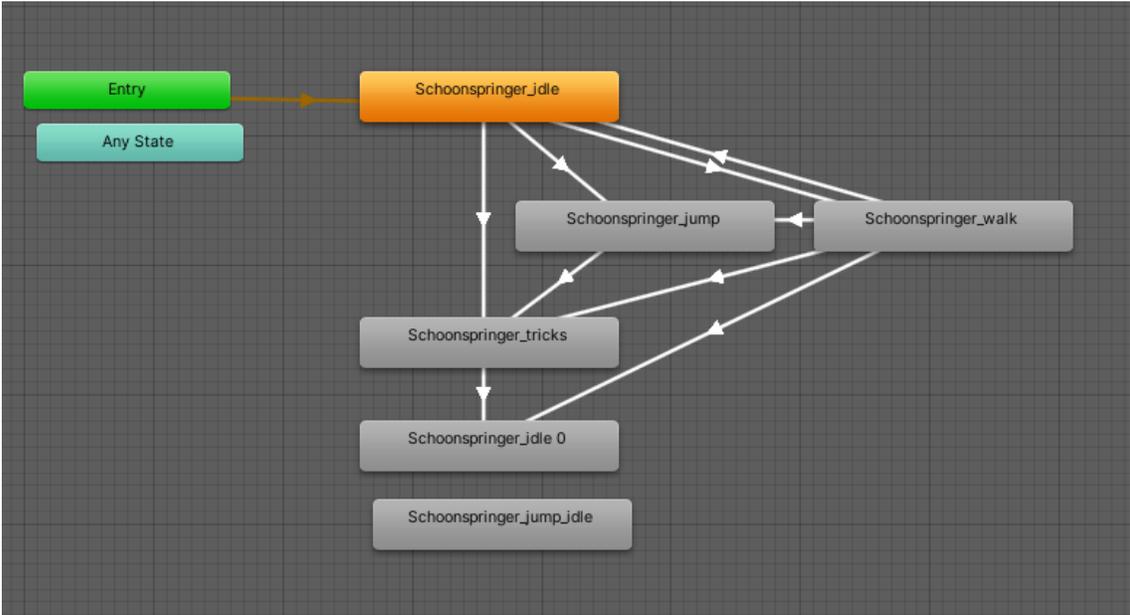


Figure 14 Unity animator containing animation transitions

12 Implementation of the art style

12.1 Cartoon researching

The first step in the process of finding an appropriate art style was researching the most popular shows from multiple children's tv channels and streaming platforms. According to The Top Ten's list of best cartoon TV channels (2013), the first three most popular cartoon channels are Cartoon Network, Nickelodeon and Disney Channel. From personal experience, two popular streaming platforms that contain children's animated series and short films are Netflix and Disney+. Multiple lists of children's shows were found on the IMDb website (Appendix A). Animated shows that have ended before 2015 have been filtered out of the listing. The cartoons listed contain very different drawing and animation styles and have been used as a basis for identifying the preferences of the target audience.

12.2 Cartoon art survey

In order to discover which type of visuals is appealing to children in the 6-11 age group, a survey has been done by the student (Appendix B). The questionnaire is meant to reveal common drawing and animation elements that are preferred by the users. The first questions asked are related to the gender and age of the participants. The answers to these questions can determine if gender or age plays a factor in the preferences of the children. The survey contains multiple images and animation clips retrieved from the list of popular cartoons described in Section 12.1. The children can specify what they like most about an image, such as colors, drawing style, shapes and surroundings.

Because the target audience consists of underage individuals, the parent's consent was required for a participant to fill in the survey. The parents were asked to fill in a consent form for their child to take part in the research. They also had the possibility of withdrawing the child's response within 24 hours from the submitting point. The parent consent form can be found in Appendix B.

These participants were found by sharing the survey with acquaintances of both the client and the student. A total of 6 answers were received within a three-week timeline. The number of participants was too low to determine if results vary depending on gender or age.

From the answers gathered, a few observations were made: Children prefer animal characters over humans, and they prefer that the characters fall into the teenager category. Additionally, 2D animations were more popular than 3D animations, so it can be concluded that there is no need for the final assets to be re-worked in a 3D style. The most popular cartoons in terms of animation and drawing style, along with their most appealing elements, were found. The results of the survey are shown in Figure 15 and Tables 2, 3 and 4.

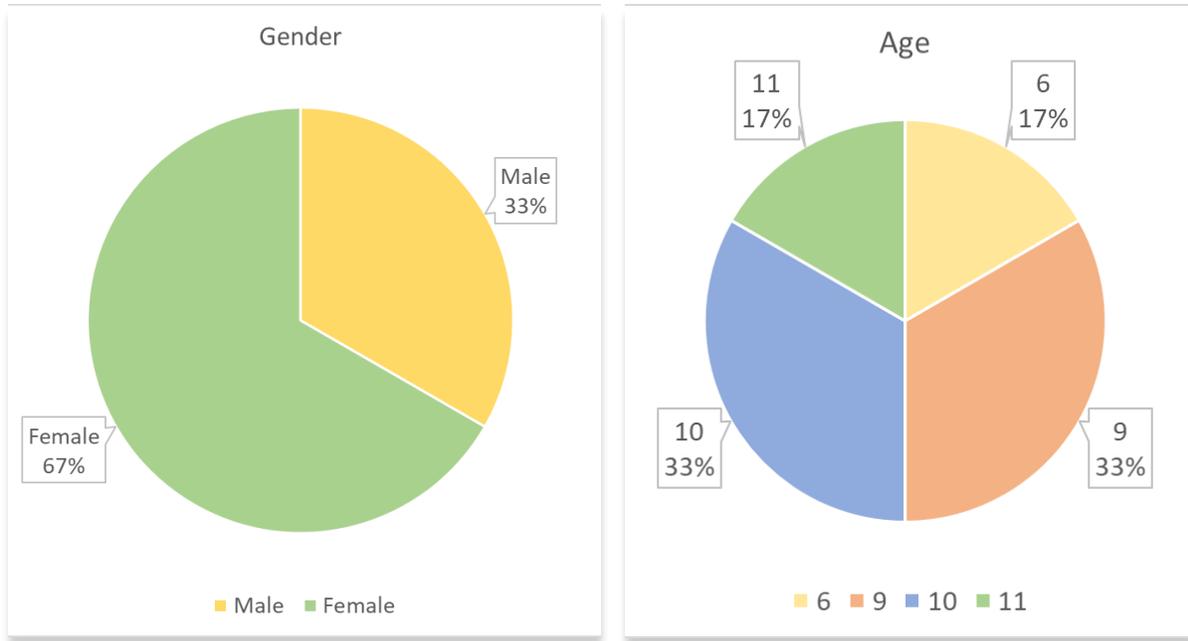


Figure 15 Gender and age distribution

Question	Answer	Percentage
What type of character do you like most?	Animal	66,7%
In what age group do you like a character to be?	Teenager	50%

Table 2 Character preferences

Platform	Question		Sub-question	
	Which image do you like most?		What do you like most about the chosen image?	
	Chosen cartoon	Percentage	Chosen element	Percentage
Disney Channel	Ducktales	50%	Drawing style	66,7%
Cartoon Network	We Bare Bears	88,3%	Drawing style / Shapes	33,3% / 33.3%
Nickelodeon	Spongebob Squarepants	50%	Colors	66,7%
Netflix	Ask the Storybots	66,7%	Shapes	50%
Disney+	Kitbull / Forky asks a question	33,3% / 33,3%	Drawing style	50%

Table 3 Comparison of cartoons in term of art style

Question		
Platform	Which animation style do you like the most?	
	Chosen cartoon	Percentage
Disney Channel	Ducktales	66,7%
Cartoon Network	We Bare Bears	50%
Nickelodeon	Alvin!!! and the Chipmunks	50%
Netflix	Ask the Storybots / Troll Hunters	33,3% / 33,3%
Disney+	Kitbull	50%

Table 4 Comparison of cartoons in terms of animation style

12.3 Product Design

The student created a final product design table after processing the results of the first survey and discussing with the client about changing some of the metaphor concepts. The characters that were adult humans have been changed to teenage animals, fitting to the specific metaphor. For example, instead of a human throwing a bowling ball, the character was changed to a teenage cat. For levels that contained objects only, such as cars or flowers, no changes have been made. Changing the objects to animals would require the whole metaphor to be re-worked, a process which would have been too time-consuming. Table 5 16 represents the levels that require new 2D assets.

Level	Main Character	Additional elements	Environment
CAR RIDING	REGULAR CAR GRADUALLY CHANGING INTO SPORTS CAR	CAR SPEED METER	CITY LANDSCAPE
DRAGON SPITTING FIRE	DRAGON DRINKING OIL AND SPITTING FIRE	OIL CANNISTER BEING EMPTIED AND CAMPFIRE GETTING STARTED	FOREST LANDSCAPE
DOG GROOMING	DOG WAVING ITS TAIL	FOAM APPEARING ON DOG WHILE BEING WASHED	DOG SALON
FLOWER PETALS BLOWN	FLOWER WITH PETALS BLOWN	LADYBUG FLYING	FOREST LANDSCAPE
BALLOON POPPING	ANIMAL SHAPED BALLOONS BEING POPPED	BOW AND ARROW FLYING TOWARDS BALLOONS	FOREST LANDSCAPE
BOWLING GAME	CAT CHARACTER THROWING A BOWLING BALL	BOWLING PINS FALLING	BOWLING ALLEY
SWIMMER JUMPING	FROG JUMPING IN WATER	AUDIENCE CHEERING	SWIMMING POOL
LIFEGUARD AND DOLPHIN	WATER TIDES MOVING BACK AND FORTH REVEALING CHEST	DOG WAVING AT A JUMPING DOLPHIN	BEACH
FOOTBALL BEING KICKED	DOG PLAYING WITH FOOTBALL	AUDIENCE CHEERING	FOREST WITH FOOTBAL PITCH ELEMENTS
ATHLETE RUNNING	ATHLETE RUNNING ON A TRACK	AUDIENCE CHEERING	RUNNING TRACK
FISHING	FISHING NET MOVING UNDERWATER	FISH, PEBBLES, AND SEAWEED FLOATING	UNDER WATER

Table 5 List of the levels that require artistic re-work

13 Potential art styles

Based on the results of the first survey, different variations of the same character have been made. Five characters were drawn in styles inspired by the most popular cartoons. Some designs contain elements from two animated series, thus creating a new art style. The character concept was a simple cat, and the most popular art style will be used in the final product. The prototype characters and their source of inspiration are showcased in Figure 16.

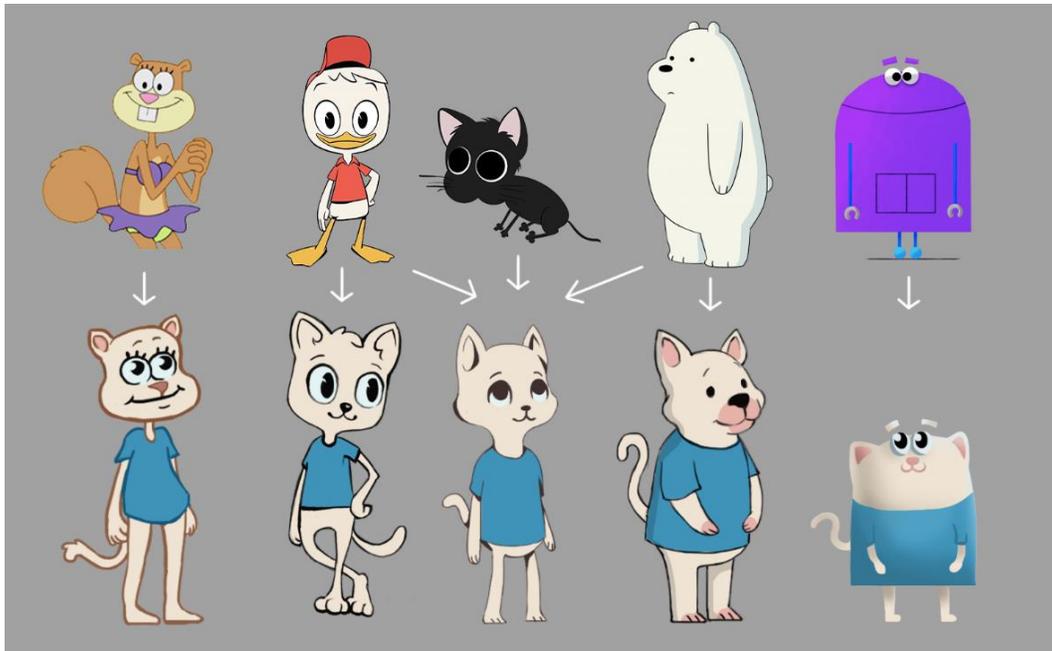


Figure 16 Prototype character options and the sources of inspiration

Four environments inspired by the results of the first questionnaire, have also been drawn. The student created two variations of a city and of a forest landscape. The styles that served as the source of inspiration for the forest were the ones from “We Bare Bears” and “Ask the Storybots” / “Kitbull”. Figure 17 showcases the first forest environment made and its source of inspiration.



Figure 17 We Bare Bears inspired forest environment

The last two cartoons mentioned have a very similar style for their environments, which looks very hand-painted and abstract, as can be observed in Figure 18.

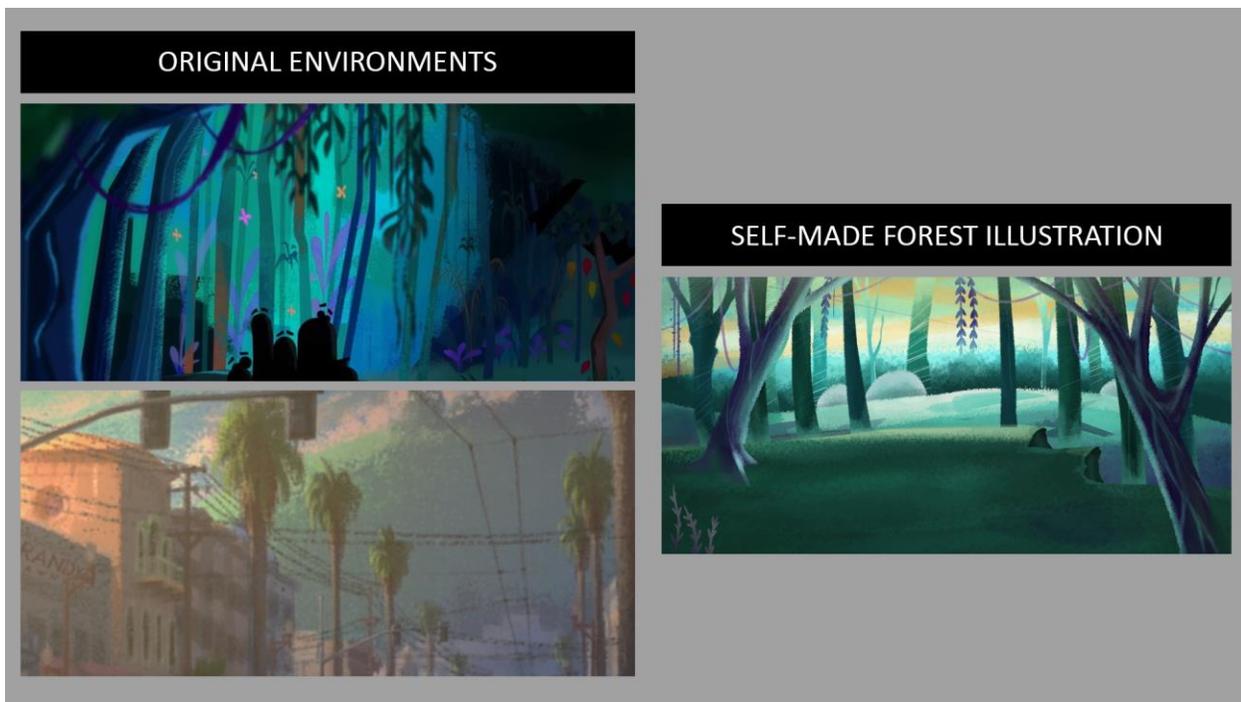


Figure 18 Ask the Storybots/Kitbull inspired forest environment

The city-themed environments were inspired by “Ducktales” and “SpongeBob SquarePants”. These are shown in Figures 19 and 20, respectively. For these illustrations, the focus was on line art, because it is the most noticeable element of these styles. In Ducktales, very straight, thin and dark lines are used, while in SpongeBob SquarePants, the lines are thicker, inaccurate and vary in color.

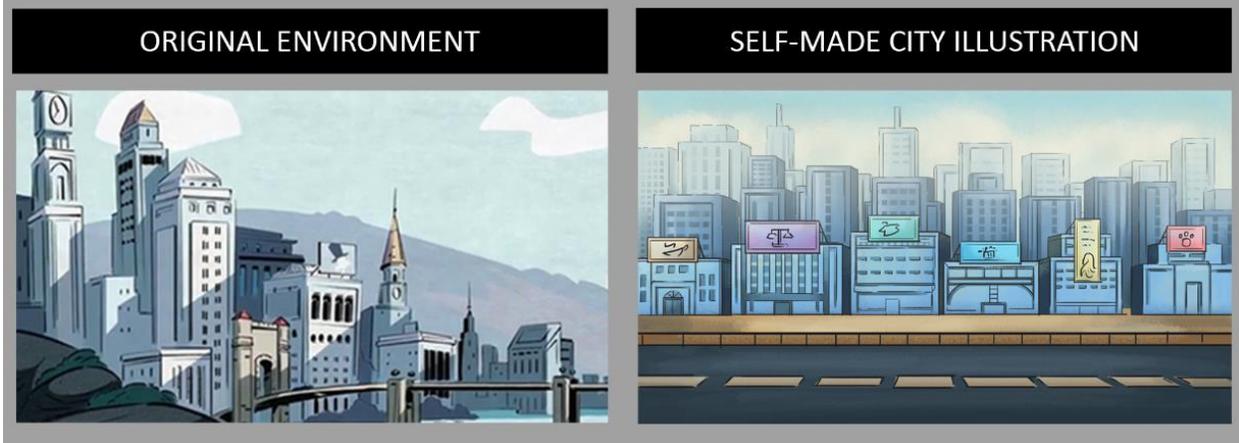


Figure 19 Duck Tales inspired urban environment

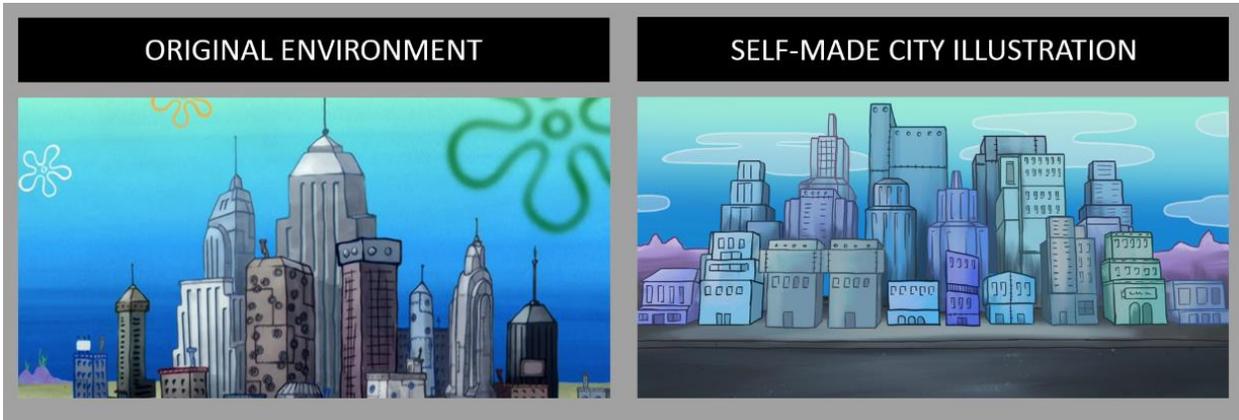


Figure 20 SpongeBob SquarePants inspired urban environment

There are noticeable differences between the sources of inspiration and the self-made illustrations, the latter being more detailed. The reason for this choice is that in a cartoon, the same background needs to be drawn from multiple perspectives, as the shots keep changing. This limits the level of complexity that can be achieved. However, in the Spiroplay application, the environment will always be viewed from the same perspective. Because the camera position will not change drastically, the student can add a considerable amount of detail to the environments in the application. This includes more complex shading, more accentuated lines where necessary and overall, a higher number of various objects and textures.

14 Final art style survey

The second survey was created with the purpose of identifying a final art style for the product. This questionnaire contained the artwork shown in Chapter 13. The focus was on character and environment design. The participants were asked to choose which art style they prefer for the characters and environments. They could also choose an element that they would change about a specific style. The elements that could be changed are:

- Brighter colors;
- Darker colors;
- Thinner lines;
- Thicker lines;
- Nothing;

If the results show that multiple options are equally popular, the student will combine these and create a final art style.

The participants were found by sharing the survey among acquaintances of the student. A total of 12 children participated. The parents were asked to fill in the same consent forms that were used in the first survey.

Figure 21 shows the options presented to the users in the three sections of the questionnaire.

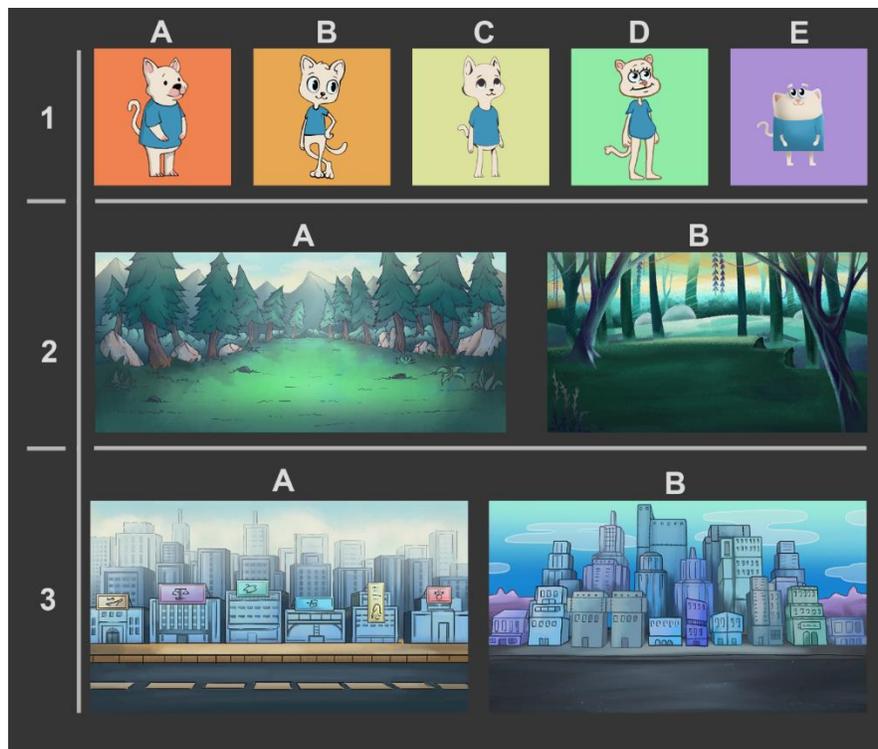


Figure 21 Second survey questions screenshot

Table 6 represents the results of the second survey. The three most preferred characters were A, B and E, the ones inspired from Ask the Storybots, Ducktales and We Bare Bears. A small part of the users would like the characters to have brighter colors, but the majority would not add any changes to the design.

The survey shows that most participants prefer forest environment B. When looking at what changes the subjects would like to see, two options stood out, tied for most votes. Most of the users suggested either no changes to be made, or the use of brighter colors.

For the urban landscape, option B had the highest percentage. The illustration was inspired by the art style from SpongeBob SquarePants, with a few changes in the shading method. The results show that children would not add any modifications to this urban environment.

SECTION	Which drawing style do you like most?		What would you change about your chosen image?	
	ANSWER	PERCENTAGE	ANSWER	PERCENTAGE
Characters	A, B and E	25% each	Nothing	58,3%
Forest environments	B	83,3%	Brighter colors, nothing	41,7% each
City environments	B	58,3%	Nothing	41,7%

Table 6 The results of the second survey

Out of all the 12 users, 7 were female and 5 were male. The differences between the two categories of participants are not drastic and do not suggest that a certain style will not appeal to either of them. One noticeable difference was that the male users would like to see brighter colors in the landscapes, while the answers from the females were more varied. The answers of the male and female participants are compared in Table 7.

	Male	Female
Preferred characters	E, A	A
Possible changes	Brighter colors	Nothing
Preferred forest environment	B	B
Possible changes	Brighter colors, Nothing	Brighter colors
Preferred city environment	A	B
Possible changes	Brighter colors, Nothing	Thicker lines

Table 7 Comparison of answers based on gender

15 The final product

15.1 The final environment style

Based on the results of the final art style survey shown in Chapter 14, the student was able to create a new aesthetic for the environment. This style was achieved by combining the line art technique used in the city landscape with the shading method used in the forest illustration. The thick outlines vary in color and look less precise. The shading was made using a stylized brush in Adobe Photoshop, which helped in achieving the desired grainy effect. The color scheme was created using the square color combination rule. The landscapes contain bright shades because the results showed that the target audience preferred brighter colors. The colors that will be used are green, yellow, blue and red. These colors are versatile and can be used to create various environments such as forests, cities or interiors. The elements that constitute the final art style can be observed in Figure 22.

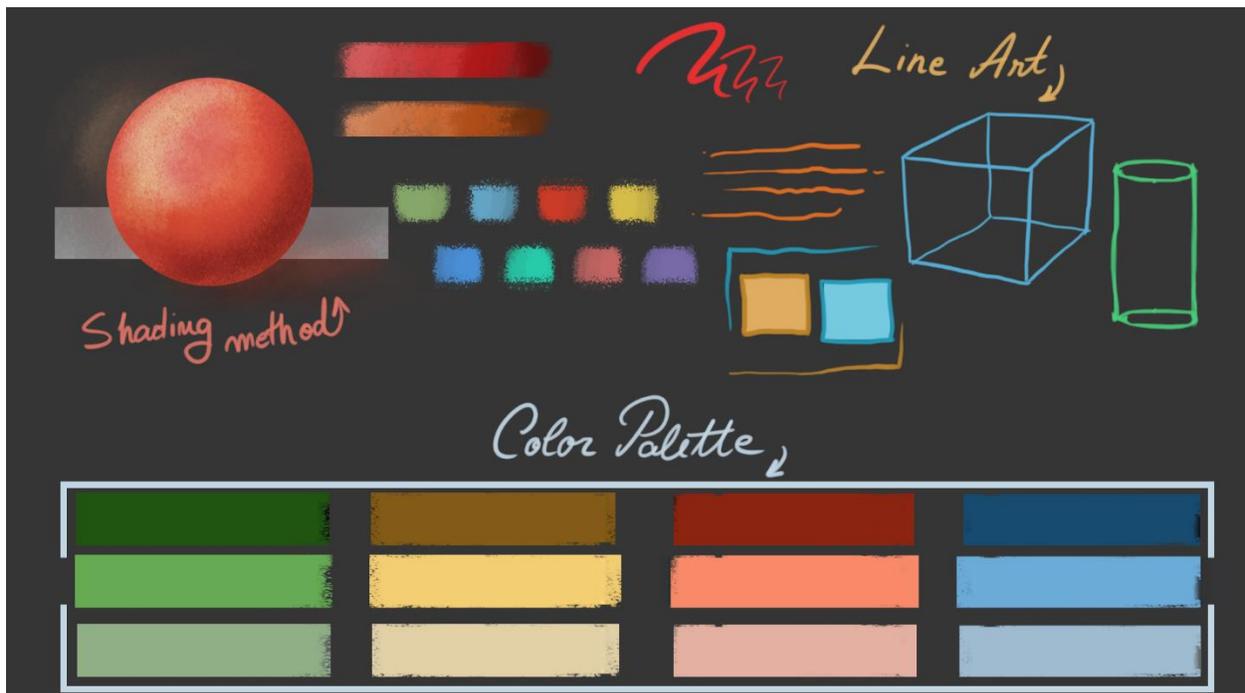


Figure 22 Style sheet for the final environment style

The Golden Ratio and The Rule of Thirds were used in the process of drawing the environments, making each of them look visually pleasing and balanced. Figure 23 shows how these methods were applied in the process of designing the landscapes. Multiple final environments can be observed in Figure 24.



Figure 23 The Golden Ratio and The Rule of Thirds applied in the environment design



Figure 24 Examples of the final environments

15.2 The final character style

Elements from the three favorite styles chosen in the second questionnaire have been mixed and used in creating three designs of the final character. The features combined were the line art, facial details and body shape. The decision of not adding any type of shading has been made due to time limitations. Of the three versions created, which are shown in Figure 25, version 1 was chosen in agreement with the client. The criteria for the final art style was that it needed to look visually pleasing and more complex than the current one in the application. Lastly, the new design had to be simple to animate. An asset that is easy to animate contains little detail while still managing to be aesthetically pleasing. After this choice was made, the placeholders of the remaining levels were re-drawn in the same style.



Figure 25 Final character options drawings

After choosing the final art style, the student re-designed all the corresponding assets in the Spiroplay application, some of them with slightly altered shapes, colors and postures. For levels that had brighter environments, the characters were given colors that would make them stand out. Various poses can be used to suggest different personalities which in turn would allow the members of the audience to relate to the characters. Although they all have smiling facial expressions, high or low confidence can be implied via different postures. Figure x showcases two examples of final characters throughout the creation process, while figure x shows multiple final versions of the characters.

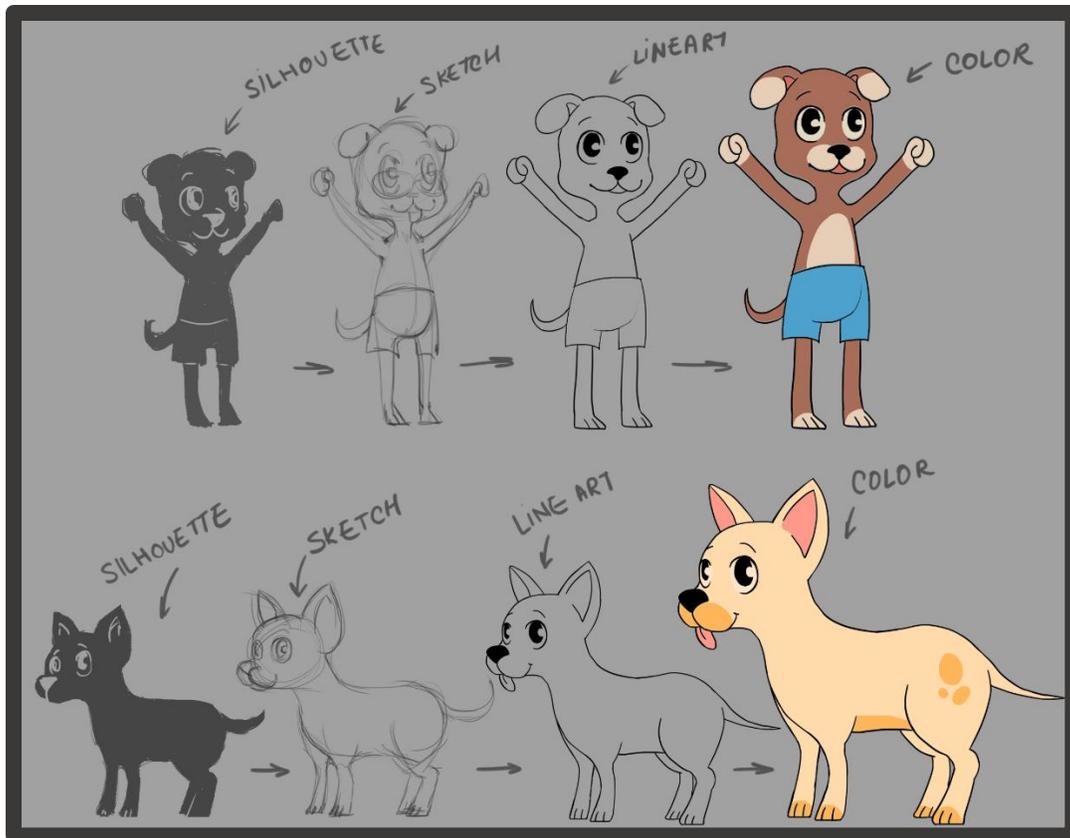


Figure 26 Examples of final characters at different stages in the creation process

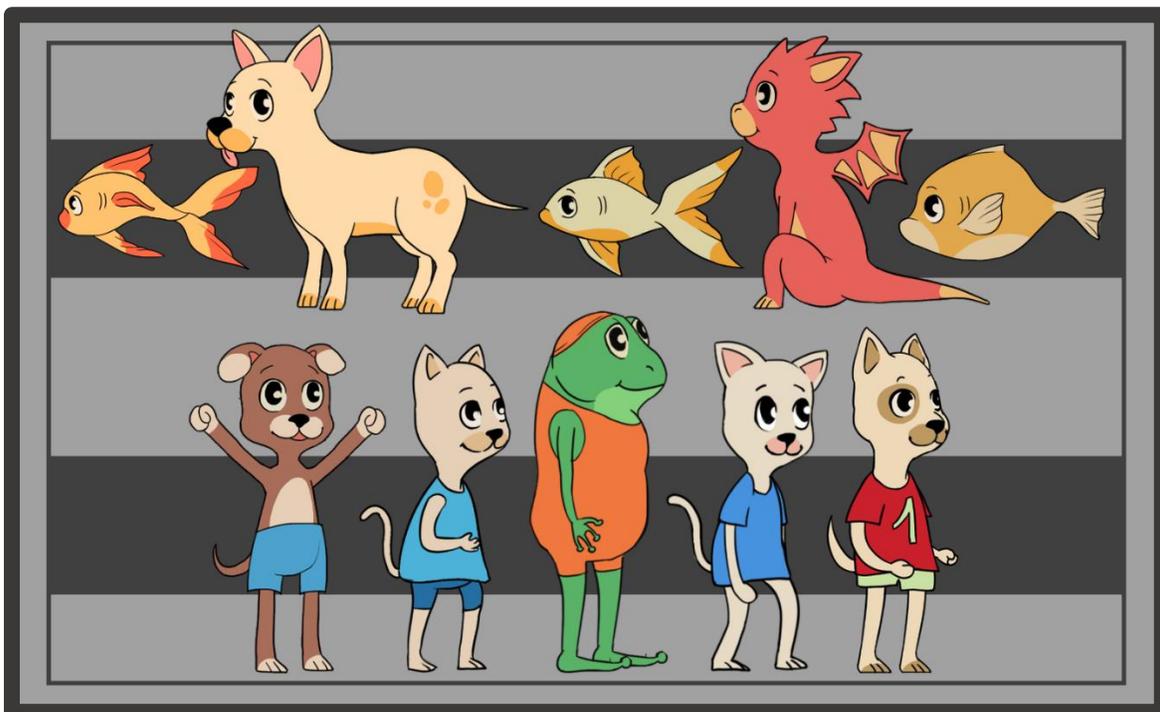


Figure 27 Multiple final versions of characters

15.3 Animations

The animations varied depending on the levels. Some metaphors required multiple animation cycles, such as idle, walking, running and jumping, while other levels needed very minimalistic animations, like just an idle movement. The movement of the characters was exaggerated when needed by stretching body parts. This was done to make the animations more suggestive and clearer to read. Figure 28 gives an example of how the dragon's body is stretched when inhaling and exhaling.



Figure 28 Key poses of the dragon inhaling and exhaling animation

For most of the character animations, the student started by creating key poses and then filled in the gaps. This helped in making sure that the student has control over the movement, and the result will be more accurate. Figure 29 showcases the key poses used in the animation of the athlete cat.

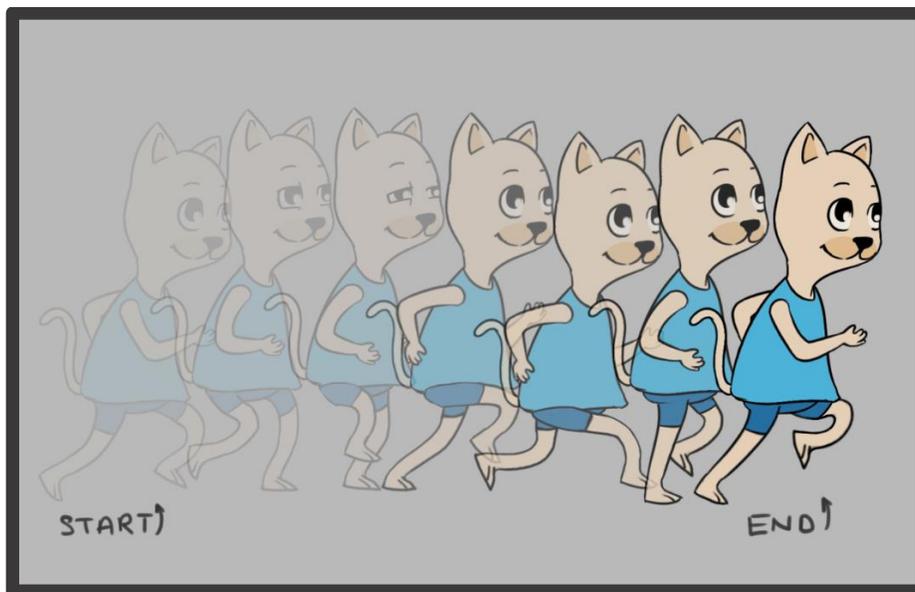


Figure 29 Key poses of the athlete cat running animation

However, for some characters, the student preferred to animate the frames in their sequence order, because the movement was supposed to be more fluid. The frog and dolphin jumping animations were created by using the straight-ahead animation technique. The jumping and fire breath animation frames can be observed in Figure 30.

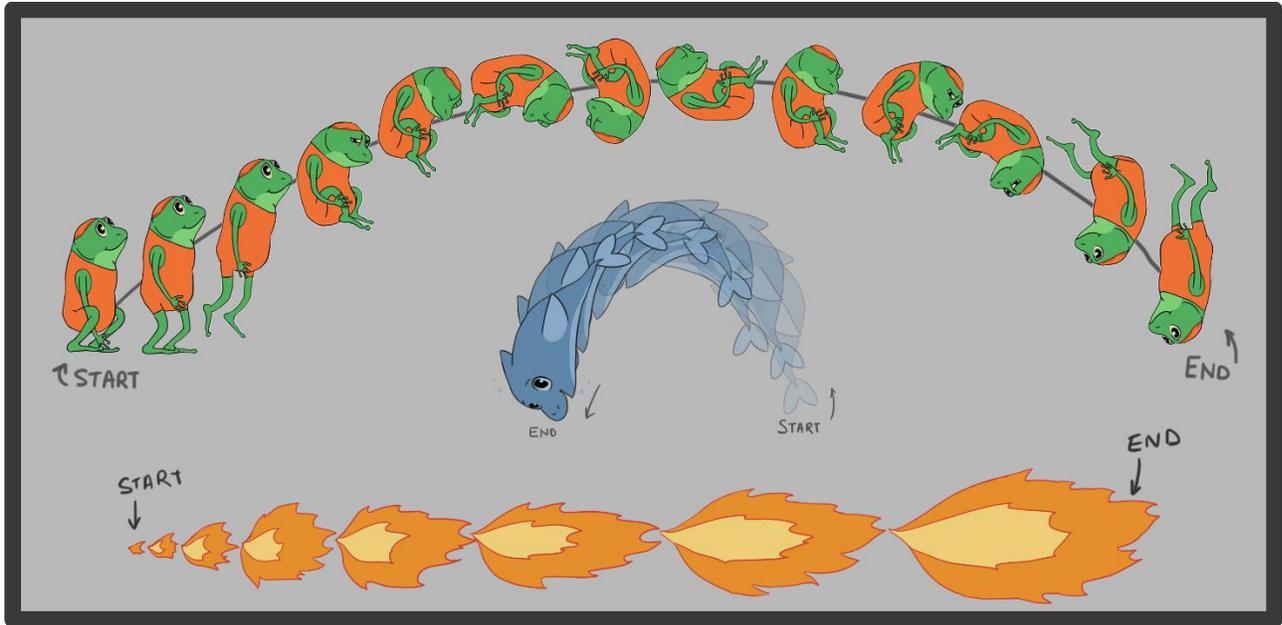


Figure 30 Animation frames of the jumping and fire animations

15.4 Final levels

The student oversaw the implementation of the 2D assets in Unity. The student collaborated with the programmer from the project to modify some of the levels because they did not have an option for integrating animations. This was done while considering the time limitations and other priorities, such as some levels needing to be polished by the programming team. There was no time to add frame animations to all the levels because they were not a priority. Multiple final metaphors can be observed in Figure 31.

The assets in the application did not exceed the size of the original ones. Where it was possible, the student decreased the size of the environments. The original environments were made at a 4k resolution, and the student reduced them to 2k or even 1k where it was possible. All the animation frames have resolutions of 256 or 512 pixels. Some of the animations made by the student have fewer frames than the originals, while the visual quality remains unaffected.

There is a noticeable difference between the frame rate of the old levels and the new ones. Because the new levels are more optimized, the frame rate increased. Two examples of the Unity statistics of the new and old levels are showcased in Figure 32.



Figure 31 Examples of final metaphors

OLD FISHING LEVEL	NEW FISHING LEVEL
<p>Statistics</p> <p>Audio: Level: -21.4 dB DSP load: 0.1% Clipping: 0.0% Stream load: 0.0%</p> <p>Graphics: <u>1460.0 FPS (0.7ms)</u> CPU: main 0.7ms render thread 0.2ms Batches: 32 Saved by batching: 1 Tris: 3.2k Verts: 7.2k Screen: 1920x1080 - 23.7 MB SetPass calls: 29 Shadow casters: 0 Visible skinned meshes: 0 Animations: 0</p>	<p>Statistics</p> <p>Audio: Level: -74.8 dB DSP load: 0.1% Clipping: 0.0% Stream load: 0.0%</p> <p>Graphics: <u>2088.8 FPS (0.5ms)</u> CPU: main 0.5ms render thread 0.2ms Batches: 17 Saved by batching: 0 Tris: 2.5k Verts: 6.4k Screen: 1920x1080 - 23.7 MB SetPass calls: 14 Shadow casters: 0 Visible skinned meshes: 0 Animations: 0</p>
OLD TIDES LEVEL	NEW TIDES LEVEL
<p>Statistics</p> <p>Audio: Level: -42.4 dB DSP load: 0.2% Clipping: 0.0% Stream load: 0.0%</p> <p>Graphics: <u>1804.6 FPS (0.6ms)</u> CPU: main 0.6ms render thread 0.2ms Batches: 21 Saved by batching: 1 Tris: 1.2k Verts: 1.8k Screen: 1920x1080 - 23.7 MB SetPass calls: 17 Shadow casters: 0 Visible skinned meshes: 0 Animations: 0</p>	<p>Statistics</p> <p>Audio: Level: -74.8 dB DSP load: 0.1% Clipping: 0.0% Stream load: 0.0%</p> <p>Graphics: <u>2056.3 FPS (0.5ms)</u> CPU: main 0.5ms render thread 0.2ms Batches: 19 Saved by batching: 0 Tris: 919 Verts: 1.5k Screen: 1920x1080 - 23.7 MB SetPass calls: 16 Shadow casters: 0 Visible skinned meshes: 0 Animations: 0</p>

Figure 32 Comparison of Unity statistics between new and old versions of levels

15.5 Menu re-design

With the time remaining, the student was able to improve the already existing UI in the app and make small adjustments so that it fits the aesthetic of the metaphors. The buttons have been re-created, similarly to the old ones but with different color, shading and lines. The backgrounds have been changed to images of landscapes from the game. The icons used for the level buttons have been changed, so they match the new visuals in the game. The font and positioning of the elements have not been altered. The menu art has been re-worked with the purpose of matching it with the rest of the game. The colors used are pastels, as opposed to the highly saturated tones from the original version. Orange and green have been chosen because these shades can also often be found in the levels. Screenshots of the new menu version are showcased in Figure 33.

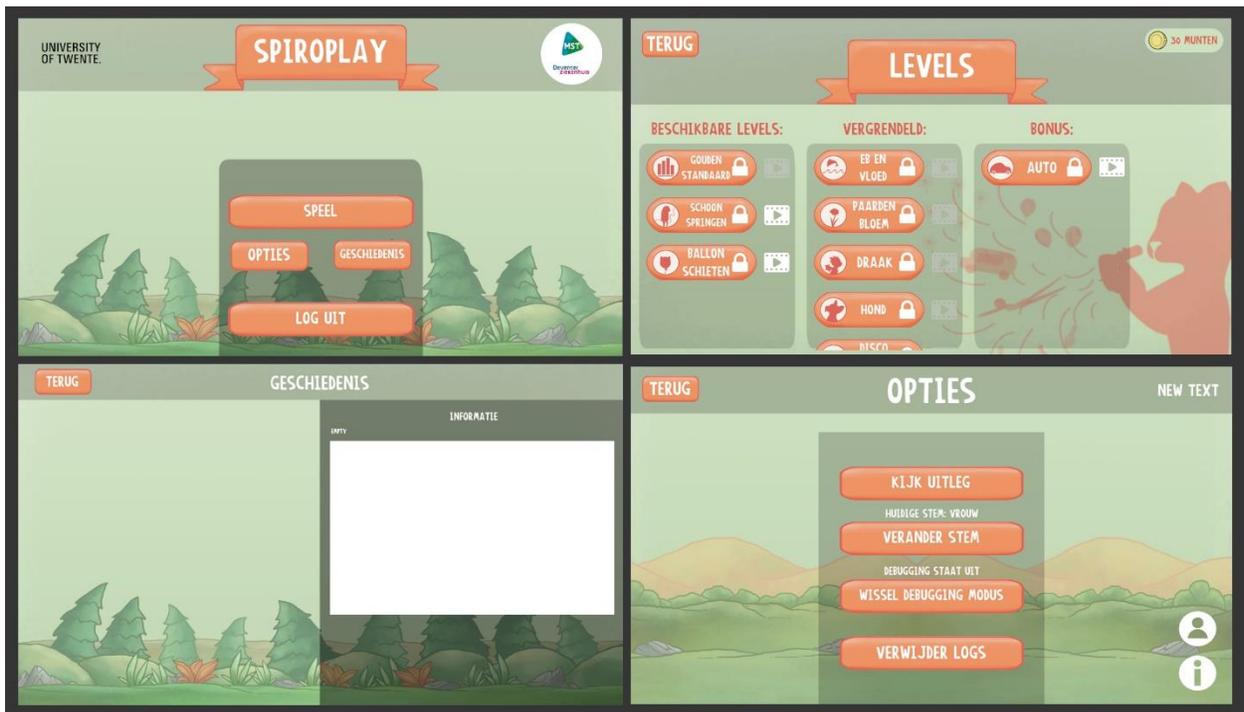


Figure 33 Re-designed menu

16 Testing the final product

In order to determine if the target audience finds the new assets appealing compared to the previous state, a testing session was needed. Due to the global pandemic and restrictions in place at the time of writing, a live play-test session of the product was not possible. Therefore, a survey was created with the purpose of gathering feedback from the specific age-group.

The questionnaire displayed five sets of animation clips, where the old and new levels are shown side by side. The five metaphors used for comparison are:

- The dog grooming level;
- The balloons level;
- The diver level;
- The dandelion level;
- The beach level;

These metaphors were chosen in agreement with the client, on the basis that these were the least popular levels before the re-work. The rating of the new versions is done on a scale from 0 to 10, with 0 being considered ugly and 10 being beautiful. Additionally, respondents had the opportunity to specify what they would like to change in the level. The options displayed are:

- Adding more decoration in the background;
- Adding special effects such as stars or sparkles;
- Adding animated text in the level;
- Nothing;

Like with the previous two surveys described in Chapters 12 and 14, participants were found through acquaintances of the student and of the client. A total of 12 responses were received.

The results displayed in Table 8 show that while all the levels have been rated higher than average, the target audience preferred the old versions in some cases. These results helped the student determine which levels needed to be improved. The changes chosen by the participants have been used in carrying out these improvements.

Level	Average grade (0 - 10)	Most voted for changes	Preferred variant (Old vs. New)
Dog level	6,5	Decorations in the background	New
Balloons level	7,3	Decorations in the background	Old
Diver level	6,5	Special effects	Old
Flower level	8,4	Nothing	New
Beach level	7,8	Nothing / Decorations in the background	Tie between both

Table 8 Results of the testing survey

17 Polishing the product

The third survey results helped the student prioritize which levels needed more polishing. Levels were adjusted according to the result of Chapter 16. Decorations and special effects have been added with the purpose of increasing the appeal of the metaphors. Additional background decorations were added to the beach level, the balloons level and the dog level. The frog level's background was slightly adjusted, and special effects like star particle systems were added. The animations and positioning of the already existing elements remained relatively unchanged. All these changes were made with the purpose of improving the quality of the visuals in the Spiroplay application. The changes made in the levels can be observed in Figure 34.

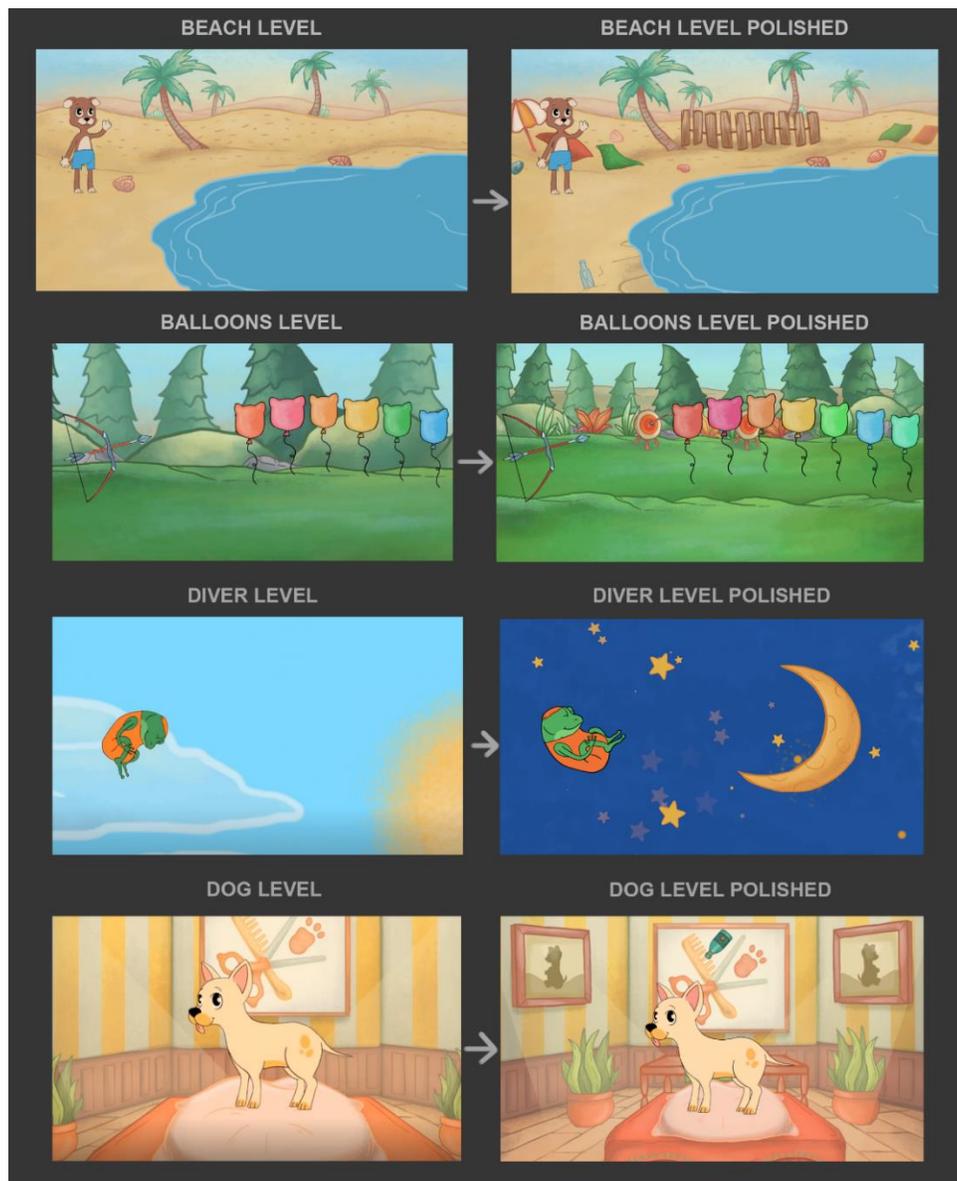


Figure 34 Comparison of various levels before and after polishing

18 Results

The knowledge required to build the final product was gathered by answering the sub research questions. Subjects like appropriate art styles for children, gender and age differences and Unity asset optimization were relevant in answering the main research question. This section will be structured around the main research question, along with the sub-questions.

1. How to create an art style that appeals to the young target audience?

Answering this question was done by researching about popular art targeted towards children. Cartoons and animated series are examples of art styles that appeal to the target audience and represent sources of inspiration. In order to find an art style that appeals to the young public, multiple prototypes must be created and tested with the participants in the target audience. The adjustments made to the prototypes based on the answers received in the surveys ensured that the art style is appropriate for children between 6-11 years old.

The final art styles of the environments include bright colors and multiple decorations in the background. The shapes of elements such as vegetation and buildings are simple and have stylized line art and shading. The characters are young looking, with big heads, big eyes, round shapes and happy facial expressions. Their colors are bright, the outlines are thin and dark, and their movement is slightly exaggerated.

2. Is age a factor that could influence the target audience's opinion on the art style?

3. Is gender a factor that could influence the target audience's opinion on the art style?

These two sub-questions were answered by gathering data from the three surveys created during this graduation project. The children had to specify their age and gender when filling in the questionnaire so that the student can analyze the results. The survey results showed that the answers of the two genders did not differ greatly. Most of the children picked the same answers, with little variations when they had to specify what they would change about an image. Based on these results, it can be concluded that gender is not a factor that heavily influences the children's opinion. However, the age subject was more difficult to study because of the lack of age variety of the participants in the first two surveys. In order to extract accurate information from the results, the participants should have been from all ages between 6-11 years old. An accurate conclusion could not be drawn from the results.

4. How to create optimized assets that do not cause performance issues in the game?

This problem was solved by studying the placeholder assets in the Unity project. Size limitations were established for the animation frames and backgrounds. Where it was possible, the student reduced the size of certain assets, making them smaller and more optimized than the initial placeholder. This led to a slight increase in the frame rate. To sum up, creating optimized assets for the application requires size limitations imposed before the process of designing the product.

“How to re-design multiple sets of 2D or 3D game-ready assets for the Spiroplay Unity serious game in an art style suitable for children between 6-11 years that suffer from asthma?”

The main research question was solved by studying the subjects of the sub-questions. A game ready asset needs to be optimized in such a way that it doesn't decrease the frame rate of the application. For the art style to appeal to the target audience, it needs to be created and adjusted based on the opinion of children between 6 and 11 years old.

The 11 re-designed metaphors of the Spiroplay application are showcased in Appendix C.

19 Discussion

Although the results of the final testing were relatively positive, and the product was polished, some things could have been done better if the student adjusted the planning and allowed more time for certain steps. This chapter will cover the obstacles encountered during the research and development stages and how they have been tackled.

19.1 Testing: The three surveys

While plenty of feedback was extracted from the three surveys created, the student did not manage to hold a live play-test session with the target audience, as it was planned in the beginning of the project. This obstacle was caused by the global pandemic that occurred at the time of writing this assignment. The target group was difficult to reach by the student because it consists of underage people, and their participation had to be approved by the parents or legal guardians. For the second survey, time limitations did not allow the student to create more types of environments, ending up with just four illustrations. The time available also did not allow the student to create a survey that contained all 11 metaphors, instead of just five. This issue could have been handled better if the planning was structured differently and allowed the student more time for testing towards the end of the project.

19.2 Unity limitations

The student collaborated with a programmer when implementing the assets in the Unity project. Some levels were programmed in such a way that frame animations could not be added. Changing the levels in such a way that would allow for frame animations to be added was not a priority. Some levels were still in progress programming-wise when the student started the implementation. The programmer changed a few levels so that they allow for frame animations to be implemented, but this process took time and could not be done for all the metaphors. Discussions about choosing functionality over visuals happened, and the student agreed to work around the technical limitations. Even though not all levels contain frame animations, the final product was deemed as visually pleasing by the target audience.

20 Recommendations

20.1 Play-testing and Interviews

After the social distancing measures imposed during the COVID-19 situation will stop, it would be recommended to hold a live-play testing session and interview with the target audience. Gathering users through acquaintances took time and organizing interviews with the children on platforms such as Skype would have been difficult for both parties. By organizing interviews with children, more questions could be asked. Therefore more information could be extracted. The target audience's answers were unpredictable most of the time, so asking more questions could help with understanding the users better. The final product couldn't be tested by a child that uses a spirometer device linked to an Android tablet, so it would be good to see how the animations play when multiple children with different breathing patterns perform the test. Another recommendation about testing is to observe over a longer period if the asthmatic children's living standards improve by using the SpiroPlay application with the artwork improved. The art style was inspired by cartoons that are currently popular, but maybe in 5 or 10 years, this situation might change because newer generations will watch different series.

20.2 Audio improvement

To bring this product to industry standards, better sound design is required. The audio present in the game right now is minimalistic and does not fit the levels anymore. To improve the audio quality in this project, it is recommended to assign an audio designer to re-work the current sound effects and maybe add new ones. Sound design is a complex process that requires an experienced artist with an affinity to sound creation and implementation.

20.3 Marketing the product

Although the SpiroPlay application is currently marketed towards children with asthma, spirometry is a procedure that can also help people affected by other conditions, such as lung infections. Having a portable, mobile-linked spirometer is an efficient way of reducing the need to travel to the hospital and the target audience could be expanded so that more patients can benefit from it. From a financial standpoint, both patients and health insurance companies would save money by reducing the number of visits to the hospital. Public hospitals, private clinics and elementary schools are institutions that could be used as platforms for distributing the product to those who may need it, thus increasing its exposure.

Because the art style has been improved compared to the previous version and appeals to the target audience, the application looks more professional and closer to the industry standards. Appealing aesthetics, along with better exposure to the public, could open new opportunities for funding this project, making it possible to develop the product further.

21 Conclusion

The purpose of this project was to improve the art style in the Spiroplay application by making it appeal to children between 6 and 11 years old. Improving the assets meant, making them visually pleasing, as well as optimized for the Unity engine. Spiroplay is built for Android tablets, which meant that the resolutions of the 2D artwork could not exceed the ones of the old assets. Ideally, for the client, once the visuals are re-worked, this application will attract multiple users, thus increasing their living standards.

Through literature study and conducting surveys with the target audience, the student was able to create multiple prototypes for the levels and adjust them based on the criticism received. The client was interested in finding out if gender or age are factors that could influence the opinion of the public. The questionnaire revealed that gender does not heavily influence the answers of the participants. The age topic was difficult to study because of the small number of users that took part in this research. The student hoped to receive answers from children of all ages from 6 to 11, but most of them were either 6 or between 9 and 11 years old.

A final testing session took place, where half of the re-worked metaphors were rated by the target audience and compared to the older versions. In some cases, the older version was preferred by the children, which helped the student determine which levels needed to be improved. The metaphors were polished by adding the improvements suggested by the children in the final testing session. By the end of the project, 11 metaphors have been re-worked art wise, along with the menu elements.

It is not clear yet if the Spiroplay application will increase the living standards of the target group because this type of testing needs to take place over a longer timeframe. The application will be finished once the levels are polished from a programming point of view and after an eventual re-design of the audio assets.

The document containing the student's reflection on the progress of the project can be found in Appendix D.

Appendices

A. Animated series list

1. Disney Channel Top 5 Most popular cartoon series 2015-2019 according to IMDb list created by user TheComicNerdz (2017)

1. Ducktales
2. Star vs The Forces of Evil
3. Amphibia
4. Tangled Series
5. Milo Murphy's law

2. Nickelodeon Top 5 Most popular cartoon series 2015-2019 according to IMDb list created by user TheComicNerdz (2017)

1. The Loud House
2. Harvey Beaks
3. Teenager Ninja Turtles
4. Alvin!!! And the Chipmunks
5. SpongeBob SquarePants

3. Cartoon Network Top 5 Most popular cartoon series 2015-2019 according to IMDb list created by user TheComicNerdz (2017)

1. Adventure Time
2. Teen Titans Go!
3. Young Justice
4. Over the Garden Wall
5. We Bare Bears

4. Netflix Top 5 Most popular cartoon series 2015-2019 according to IMDb list created by user Wisemaster (2018)

1. The Dragon Prince
2. Hilda
3. She-Ra and the Princesses of Power
4. Trollhunters
5. Ask the Storybots

5. **Disney+ Top 5 Most popular cartoon series 2015-2019 according to IMDb list created by user JacobTubeHD** (2019)

1. Kitbull
2. Forky asks a question
3. Float
4. Smash and Grab
5. Star Wars: Clone Wars

B. The parent consent document translated to English.

SpiroPlay-Art 1.0 – It.nc.acc.pcc – 19/20 – v1.00

toegekend door onderzoeker

TOESTEMMINGSVERKLARING (INFORMED CONSENT)
Regarding
The University of Twente and Saxion University of Applied Sciences are researching the use of "smart" technology to improve breath tests to monitor lung function for children with asthma, as explained in the information brochure "SpiroPlay - Art Styles" that is provided with this form.

Principal investigators:
Robby van Delden¹, Alejandro Moreno², Diana Focsaneanu² ¹University of Twente ²Saxion University of Applied Sciences

Contact information
If you have any questions about this research, please contact Robby van Delden (rvvandelden@utwente.nl, van Loenshof 28, 7511 HG Enschede, +31534893925) or the secretary of the Ethics Committee (ethics-comm-ewi @ utwente.nl, Zilverling Room 1051, Drienerlolaan 5, 7522 NB Enschede, +31534892085). The Ethics Committee is made up of independent experts from the university and is available for any questions and complaints about the research.

Research: SpiroPlay – Art Styles

I hereby declare the following for the 2019/2020 school year:

- I hereby declare that I am fully informed about the research. The purpose of the research and the methods have been explained to me, and I have had the space to ask questions.
- I understand that I can and can end my participation at any time, without giving any reason, without any consequences (including later in the school year). This can be done up to 24 hours after participating, please indicate the time of participation.
- I will verbally ask for my child's permission to participate ("Do you want to participate in "answering these questions" / "testing this game?"), And if they indicate (whether or not in behavior) want to stop ending the test.
- I hereby give my prior permission for my child's participation and participation in research during the 2019-2020 school year and for the collection and use of anonymous data as described in the information folder.
- I declare to make publicly available the anonymous research materials collected when participating in the study.

Images are only viewed by involved researchers and will never be made public and / or shown to third parties for demonstration or reporting. All research material will be processed and stored in accordance with the rules and guidelines of the GDPR. All data is stored for a minimum of 10 years, in accordance with the NVSU guideline.

I also give permission to be contacted at the following email address for a next step, to view the drawing made based on the results of the questionnaire:
.....

I authorize the use of a video calling program for research purposes in this possible next step.

Date: _____ Place: _____

The researchers digitally separate the top and bottom parts for preservation of anonymity, as soon as the data collection is complete. -----

Name of your child: _____ Signature(s) of parent(s)/representative(s): _____

.....

C. Video showcasing the final versions of the 11 metaphors:

https://www.youtube.com/watch?v=v008TQ3_FsA&fbclid=IwAR04-Bkwp4Ys4wGNxTEenVW493MJHnGfEhTyvkMVYWmkaYcNeqFat7zsvws

D. Reflection on the progress of the project

Reflection

1. Technical research and analysis

This graduation assignment was a challenge for me because I have never created assets for a Unity game that was built for the Android platform. I had to learn how to create 2D assets that are optimized while also making everything visually pleasing. I have managed to improve the art style in the Spiroplay application, while not exceeding the technical limitations. Where it was possible, I reduced the assets to a resolution that is lower than the initial placeholder art.

While I was quite confident in my 2D concept art skills, the animation part was a discipline that I wanted to improve upon. This project allowed me to learn how to create 2D animations in Adobe Photoshop, which is a program that I am familiar with when it comes to creating illustrations. Still, I haven't been using for other purposes very often.

By the end of the graduation project, my 2D animation skills improved drastically. By creating prototypes and later final animations for the 11 metaphors, I became experienced with the process of using Adobe Photoshop for this purpose. My overall drawing skills improved as well because the animation process helped me get a better understanding of posing a character and suggesting its personality through posture and expression.

2. Designing and Prototyping

After I researched relevant topics such as environment drawing, designing a character and 2D animation, I applied the knowledge gathered by creating prototypes for the application. I produced multiple options for the character design, as well as the environments. My product had gone through two iterations before I deemed it as final. Using the CMD research methods pack helped me in the process of collecting feedback from the target audience.

The prototypes that I created were tested through surveys. The feedback received helped me create a style for the characters and environments. I combined elements from the most selected answers, and a final version was designed.

The last step was to polish the final product. The last survey showcased what new elements need to be added to improve the visuals. The participants wanted to see more decorations in the environments, as well as special effects such as sparkles and stars.

Collecting and applying the suggestions of the target audience helped me ensure that the product will appeal to the public.

3. Testing and rolling out

Although a live play-testing session was planned, the global pandemic that occurred during the graduation assignment made it impossible to carry out this plan. Therefore, testing the final product was done through surveys.

During the design and production phases of this project, I created three surveys and distributed them to members of the target audience. The first questionnaire helped me determine which elements should be used when creating an art style for the environments and characters.

The second questionnaire included multiple prototypes of the characters and environments. It was determined that multiple options appealed to the target audience equally. The information extracted from this survey was used in creating a new art style by combining elements from the most popular prototypes.

The final product was tested by conducting a survey as well. The results of this questionnaire were meant to reveal if the target audience prefers the old artwork or the re-worked version. In some cases, the older versions were considered better by the children, which helped me prioritize the levels that needed to be polished.

4. Investigating and analyzing

During this graduation semester, I used the CMD methods pack, more specifically, the Literature Study and the A/B testing methods. I researched topics such as serious games, 2D animation, environment design and character creation. Researching these topics helped me get a better understanding of the steps that needed to be taken in order to build the final product.

The surveys that I made helped me determine what kind of art appeals to a young target audience. The information that I gathered was used as a basis in the process of creating 2D assets for the 11 metaphors in the Spiroplay application.

5. Conceptualizing

Before building the final product, I created multiple sketches for the characters and environments. These drawings have been made with the purpose of exercising my drawing skill and experimenting with different shapes, line art, postures and facial expressions. I created several variations of potential art styles for the assets in the game, which have been inspired from sources such as animated series. I tried replicating certain styles, as well as merging the elements found in multiple cartoons to create a new style.

6. Designing

The target group for the SpiroPlay project is children between 6-11 years old that suffer from asthma. In order to find an art style that appeals to the target audience, I researched the art style of multiple cartoons that are popular nowadays. I experimented with multiple art styles and tested my ideas with the public until I created a final art style. Keeping the levels consistent was achieved by creating style sheets.

The technical limitations were a topic that I had to study in order to create optimized assets. By analyzing the Unity project, I managed to determine what the size limitations were, so that my assets would not exceed these limitations and cause frame rate issues.

My final product meets the criteria of being appealing to the target audience, and my assets are optimized.

7. +8. Enterprising competencies

The re-worked assets that I created are an element that brings the SpiroPlay application closer to industry standards. Although this application is marketed towards children with asthma, the audience could be expanded to people with other lung-related conditions. From a financial point of view, this product is a cheaper option for the patients, comparing to the cost of travelling to the hospital and doing regular check-ups. The client can benefit from my work done during this graduation semester because the application looks better and is more likely to attract multiple potential buyers.

9. Working in a project-based way

From the beginning of this graduation semester, I had weekly meetings with the client where I shared my progress, and we discussed ideas related to the next steps. I always showed my work and applied the suggestions that I received from the client. I asked for feedback and helped when I encountered obstacles, such as finding potential participants for my survey.

When I started implementing the assets in the game engine, we used Unity Collab for merging our scenes and implementing changes to the project. I implemented my assets in an organized way, without creating conflicts with the old artwork. Whenever I submitted my progress, I wrote a small description of the changes that I have made.

I asked for help from a programmer in our team when my technical knowledge was not good enough to adjust the levels the way I wanted. I communicated clearly about the changes that I need to make, and we collaborated very well. Google Drive was used as a back-up storage space for the 2D assets, even though they were also implemented in Unity.

Overall, working in the SpiroPlay team was an enjoyable experience for both parties.

10. Communication

In my final report, I documented my entire progress from the beginning of the graduation semester up to this point. The thesis follows the instructions given in the graduation manual:

- APA format
- Under 25 pages
- Under 10.000 words excluding the Abstract, Appendix, etc.
- 10.5 font size

I used Grammarly to check the spelling errors in and grammar issues, as well as verifying the sources. The report was proof-read by a colleague in my graduation group to ensure that it is clear and easy to understand from another person's perspective. I used multiple illustrations to support the written information in my report. The structure that I used is fitting the theme of my graduation project.

I believe that I communicated in a clear and appropriate manner with my client and graduation coach.

11. Learning ability and reflectivity

I believe that this graduation semester helped me improve my artistic and professional skills. I asked for feedback from my client often and developed my product based on his feedback. I took every piece of criticism as an opportunity to expand my knowledge and skills. There are aspects that I would like to improve upon still, such as my planning skills and networking. The whole experience of being a part of the SpiroPlay team helped me prepare for my future career in the gaming industry.

Although my target audience was difficult to reach, I could not rely on getting feedback only from my peers. My acquaintances helped me gather participants from my survey, and I managed to get useful feedback that I applied when adjusting my artwork.

12. Responsibility

Because my target audience consisted of underage individuals, I had to ask for the approval of the parents before a child answered my questionnaires. The client provided me with a consent form that needs to be signed by the parent or legal guardian before a child filled in my surveys. In this form, the parent declares that they agree with their child's participation in my research and that they can withdraw the answers within one day of the submitting point. Asking the parents for their consent ensured that the student had a legal and ethical process of interacting with the target audience and gathering information from them.

Bibliography

- Additane, S. (2017, December 14). *How I learnt about color theories and made my best color palettes in one month*. Retrieved from Medium: <https://medium.com/learning-lab/how-i-learnt-about-color-theories-and-made-my-best-color-palettes-in-one-month-a461604ca669>
- Boeschoten, S. A., Buysse, C. M., Merkus, P. J., Wijngaarden, J. M., Heisterkamp, S. G., Jongste, J. C., . . . Hoog, M. d. (2018). Children with severe acute asthma admitted to Dutch PICUs: A changing landscape. *Pediatric Pulmonology*, 857–865.
- Chapman, C. (2010, January 28). *Color Theory for Designers, Part 1: The Meaning of Colo*. Retrieved from Smashing Magazine: <https://www.smashingmagazine.com/2010/01/color-theory-for-designers-part-1-the-meaning-of-color/>
- Cirino, E. (2017, May 12). *Spirometry: What to Expect and How to Interpret Your Results*. Retrieved from healthline: <https://www.healthline.com/health/spirometry>
- CMD Methods. (2015, December 21). *CMD Methods Pack*. Retrieved from CMD Methods: <https://www.cmdmethods.nl/>
- Columbia University Press. (2020, March 5). *Digital Art*. Retrieved from Encyclopedia.com: <https://www.encyclopedia.com/reference/encyclopedias-almanacs-transcripts-and-maps/digital-art>
- Designing Digitally. (2018, April 16). *All about serious games: Types and purposes*. Retrieved from Designing Digitally: <https://www.designingdigitally.com/blog/2018/04/all-about-serious-games-types-and-purposes>
- FEGHALI, W. (n/d, n/d n/d). *PAINTING ENVIRONMENT CONCEPTS*. Retrieved from evenant: <https://www.evenant.com/design/painting-environments-in-no-time>
- Fitzgerald, R. (2018, October 5). *What Is 3D Animation?* Retrieved from CG Spectrum: <https://www.cgspectrum.com/blog/what-is-3d-animation>
- Fitzgerald, R. (2019, September 6). *What Is Concept Art?* Retrieved from CG Spectrum: <https://www.cgspectrum.com/blog/what-is-concept-art>
- Gallucci, M., Carbonara, P., Pacilli, A. M., Palmo, E. d., Ricci, G., & Nava, S. (2019). Use of Symptoms Scores, Spirometry, and Other Pulmonary Function Testing for Asthma Monitoring. *Frontiers in pediatrics vol 7*: 54.
- Growthengineering. (2016, March 1). *What are serious games?* Retrieved from Growthengineering: <https://www.growthengineering.co.uk/what-are-serious-games/>
- Harder, J. (2020). *Designing Characters with Personality and Expression*. Retrieved from Artstation: <https://www.artstation.com/learning/courses/pDK/designing-characters-with-personality-and-expression/chapters/3O1/outfit>

- Harper, C. (2017, March 1). *What is framerate?* Retrieved from Maketecheasier:
<https://www.maketecheasier.com/what-is-framerate/>
- JacobTubeHD. (2019, December). *Disney Plus Originals*. Retrieved from IMDb:
https://www.imdb.com/list/ls095817432/?sort=user_rating,desc&st_dt=&mode=detail&page=1&genres=Animation%2CFamily&release_date=2015%2C2019&ref_=ttls_ref_yr
- Johnston, R. (n/d, n/d n/d). *SHOULD YOU HAVE YOUR OWN SPIROMETER?* Retrieved from PFTPatient:
<https://pftforum.com/patient/should-you/should-you-have-your-own-spirometer/>
- Kiss, R. L. (2020). *Getting Some Perspective*. Retrieved from Artstation:
<https://www.artstation.com/learning/courses/V3/getting-some-perspective/chapters/YQp/summary-of-everything-in-one-visual>
- Korolev, S. (2019, March 6). *MoSCoW Method: How to Make the Best of Prioritization*. Retrieved from Railsware: <https://railsware.com/blog/moscow-prioritization/>
- Leeuwe, M. (2019). *How to draw characters*. n/d: n/d.
- LongFonds. (n.d.). *What is asthma?* Retrieved from LongFonds: <https://www.longfonds.nl/astma/alles-over-astma/wat-is-astma>
- Miller, M. R., Hankinson, J., Brusasco, V., Burgos, F., Casaburi, R., Coates, A., . . . Wanger, J. (2005). Standardisation of spirometry. *European Respiratory Journal* , 319-338.
- mohit100. (2013). *Top Ten Best Cartoon Channels*. Retrieved from The Top Ten's:
<https://www.thetoptens.com/best-cartoon-channels/>
- Petty, J. (n/d, n/d n/d). *What is Unity 3D & What is it Used For?* Retrieved from Concept Art Empire:
<https://conceptartempire.com/what-is-unity/>
- Plessis, E. d., Swart, F., Maree, D., Heydenreich, J., Heerden, J. v., Esterhuizen, T. M., . . . Koegelenberg, C. F. (2019). The utility of hand-held mobile spirometer technology in a resource-constrained setting. *South African Medical Journal*, 109(4), 219-222.
- Richard, S. W. (2020). *Painting Over 3D Renders - Part 1 - Introduction*. Retrieved from Artstation:
<https://www.artstation.com/learning/courses/Nm2/introduction/chapters/733/edges-textures-and-finishing>
- Richard, S. W. (2020). *Painting Over 3D Renders - Part 1 - Introduction*. Retrieved from Artstation:
<https://www.artstation.com/learning/courses/Nm2/introduction/chapters/733/edges-textures-and-finishing>
- Schell, J. (2008). The game is made for a player. In J. Schell, *The Art of Game Design: A book of lenses, vol. 1* (pp. 100-108). Burlington: Elsevier Inc.

- Schell, J. (2015). Games Transform Their Players. In S. Jesse, *The Art of Game Design : A Book of Lenses vol. 2* (pp. 500-515). Enschede: EBSCO Publishing.
- Stefyn, N. (2019, July 16). *What Is 2D Animation? Everything You Need To Know*. Retrieved from CG Spectrum: <https://www.cgspectrum.com/blog/what-is-2d-animation>
- Stefyn, N. (2019, July 16). *What Is 2D Animation? Everything You Need To Know*. Retrieved from CG Spectrum: <https://www.cgspectrum.com/blog/what-is-2d-animation>
- Techopedia. (n/d, n/d n/d). *Adobe Photoshop*. Retrieved from Techopedia: <https://www.techopedia.com/definition/32364/adobe-photoshop>
- TheComicNerdz. (2017, March 8). *Cartoon Network Shows*. Retrieved from IMDb: https://www.imdb.com/list/ls064701374/?sort=moviemeter,asc&st_dt=&mode=detail&page=1
- TheComicNerdz. (2017, May 16). *Disney Channel Cartoons*. Retrieved from IMDb: https://www.imdb.com/list/ls069458337/?sort=list_order,asc&st_dt=&mode=detail&page=1&title_type=tvSeries&release_date=2015%2C2019&ref_=ttls_ref_yr
- TheComicNerdz. (2017, May 4). *Nickelodeon Cartoons*. Retrieved from IMDb: <https://www.imdb.com/list/ls069383567/>
- Thomas, F., & Johnston, O. (1981). The Principles of Animation. In F. Thomas, & O. Johnston, *Disney Animation: The Illusion of Life* (pp. 47-71). New York: Disney Editions.
- Tinelli, N. (2019, June 8). *The Golden Ratio: origin of the Rule of Thirds*. Retrieved from Nicholas Tinelli: <https://nicholastinelli.com/the-golden-ratio-origin-of-the-rule-of-thirds/>
- Wensley, D. C., & Silverman, M. (2001). The quality of home spirometry in school children with asthma. *Thorax vol. 56*, 183-185.
- wisemaster. (2018, September 16). *Highest Rated Children's TV Series on Netflix of 2018*. Retrieved from IMDb: https://www.imdb.com/list/ls028165007/?sort=user_rating,desc&st_dt=&mode=detail&page=1&genres=Animation%2CFamily&release_date=2015%2C2019&ref_=ttls_ref_yr