Spring 24: HCI/d Capstone
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1. Introduction **3**
1.1 Research and Design Activities 4
2. Design Frame **5**
Fig 1. Design Frame 1 7
Fig 2. Design Frame 2 8
3. Primary Research **9**
4. Secondary Research **10**
Fig 3. Working of a Wacom Tablet 11
Fig 4. Working of a Wacom Pen 13
5. Ideation 1.0 **17**
Fig 5. Digital Assistant 19
6. Starting over from scratch **20**
7. Ideation 2.0 **22**
Game 1 - Familiarizing with the Drawing Tablet's Boundaries 23
Game 2 - Exploring Pressure Sensitivity with the Digital Pen 25
Game 3 - Integrating Pressure Sensitivity and Spatial Awareness 27
8. Paper Prototyping **28**
9. Figma Prototyping **31**
10. Reflecting on the Process **40**
References **41**

1. Introduction

The aim of my project is to simplify the user experience for first-time users (specifically hobby artists) of non-screen drawing tablets. In the past, these tablets have been predominantly used by professionals in the design industry, but recent advances have made them accessible to a broader audience. Brands like Wacom and Huion offer these tablets at a lower price point which is great for first-time users as they purchase the tablet with the intention of experimenting with it and seeing if they like the tool. Not only are they budget-friendly, non-screen tablets are built sturdy (without a delicate screen) and are built to be compatible with a wide range of software and functionalities.

Despite all these pros, non-screen tablets present significant challenges for newcomers, particularly when trying out for the first time. Mastering hand-eye coordination when using this tablet can make figuring it out tricky and frustrating. This takes away the focus from learning digital art to learning how the tablet works, which down the line demotivates the user and has them abandon the tablet.

The project's primary objective is to prevent this by enhancing the initial interaction between the user and the tablet. By reducing the learning curve, I want to make the digital art process more intuitive and enjoyable for artists transitioning from traditional to digital mediums.

To achieve this, my approach will involves identifying the key pain points in current tablet designs through user research, exploring existing and experimental technological enhancements, and developing educational tools or adjustments to the user interface that aid in overcoming these initial barriers. Ultimately, the goal is to empower hobbyists and art enthusiasts to seamlessly integrate digital tools into their creative processes, to foster both satisfaction and artistic growth.

1.1 Research and Design Activities

1. User Research:

Interviews: Interviews were conducted in more of an unstructured manner. I spoke to both amateur and professional artists and tried to get a general understanding of their views of drawing tablets, what they use now, what they started with and what the major issues seemed to be. These were more conversational than a proper interview and I wanted to have a starting point to validate doing this project and trying to see what direction I can go with it.

Contextual Inquiry: Once I did some secondary research, I conducted Contextual Inquiry with 4 artists (1 professional, 2 amateur, 1 beginner). The users were given a task of drawing an image they liked and were asked to talk out loud about the process. I also asked them a few questions about how they got into art and why they started digital art and their likes and dislikes about the process.

2. Usability Testing:

Prototype Testing: I made low-fidelity and mid-fidelity prototypes, to test out the concepts I had in mind. I worked with both paper prototypes and Figma prototypes to get a better sense of what worked and what didn’t

3. Design Iteration:

Iterative Design: After every usability testing, I refined the prototypes according to the feedback. Making these incremental changes and continuously testing them helped me get closer to the optimal design solution.

Feedback Loops: Throughout the semester I presented my design ideas either in class in the form of gallery walks or tried to discuss it with my peers outside of class.

4. Secondary Research:

I conducted secondary research to understand, the current working of the Wacom tablet, explore experimental tablet solutions and learn how to make repetitive learning engaging.

2. Design Frame

Setting the Scope

Before diving deep into the practical aspects of my capstone project, it was important to establish a well-defined design frame. This framework will serve as a guiding structure, helping me focus my efforts and solve the problem space efficiently. To initiate this process, I identified the design limitations that would set the boundaries within which I could innovate and explore solutions.

Design Limitations:

The primary user base for this project is first-time users of non-screen tablets, specifically hobby artists looking for budget-conscious and cost-effective solutions. The Wacom tablet became a focal point for its affordability and popularity as a starting tool among beginners. Given these parameters, the project is tailored to enhance, rather than change the existing design of the tablet. The aim is to simplify the tablet's functionality, thereby enriching the user's experience without altering the fundamental design of the product.

This approach ensures that enhancements are feasible and relevant within the constraints of what is already familiar to users.

Design Challenge:

The core challenge of this project is: **"How Might We improve the engagement factor by reducing the learning curve of a non-screen tablet for a first-time user?"** This question captures the essence of the design problem i.e. making the user experience more captivating and less daunting for new users. The learning curve associated with mastering a non-screen tablet can be a significant barrier to user satisfaction and long-term engagement. Therefore, addressing this challenge is about developing interventions that make the learning process more intuitive and enjoyable, encouraging sustained use and deeper exploration of the tablet's capabilities.

The first design frame I came up with is:

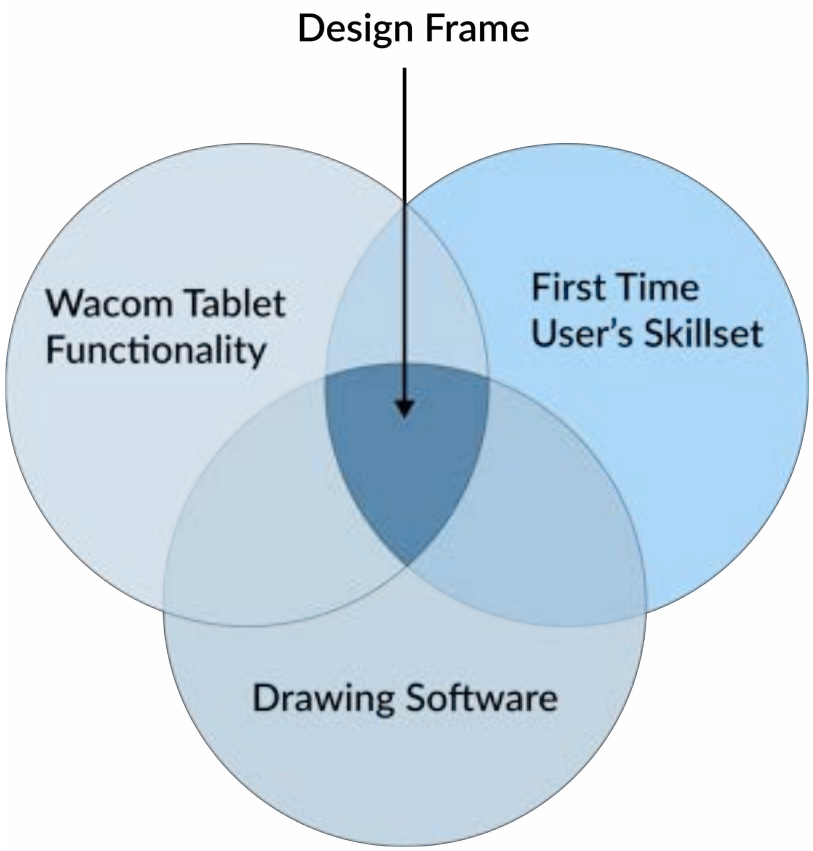


Fig 1. Design Frame 1

This design frame addressed the overwhelming feeling the user might face when looking at the abundance of resources out there to learn how to make digital art. The aim was to design a software aid that helps gather information and give it to the user in the form of a useful tutorial or resource bank. When I tested this idea with Prof Colin last semester, I was told that this frame failed to address the initial pain points and took the project into a very different space. The solution idea was also lacklustre and didn't feel like it would solve the core problem.

With this feedback, I modified the frame keeping in mind the core problem. Non-screen tablets are hard to tackle and users need help figuring it out. The new frame is:

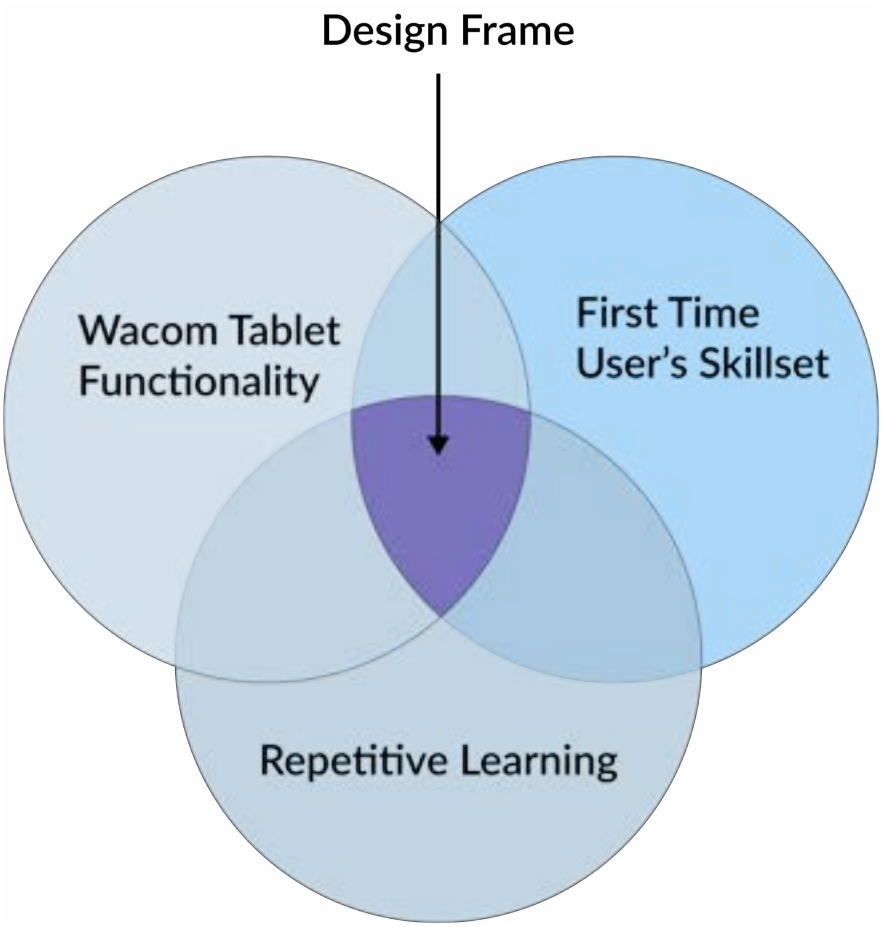


Fig 2. Design Frame 2

This new frame addresses the problem that the user does not have the skills required to make a piece of art but the problem lies in understanding the functionality of a Wacom tablet and maintaining motivation to learn it through repetition.

3. Primary Research

To understand how the user interacts with the product, I conducted Contextual Inquiry to gain The participants were asked to introduce themselves, discussing their professional background, their artistic skill level, their experiences with digital art, and the tools they typically use to make digital art. Following this introduction, users were tasked with creating a sketch, during which they were encouraged to verbalize their thought processes, such as their reasons for choosing specific brush types or making particular gestures with the pen or tablet.

Originally I planned to observe various users across different media to identify any underlying subconscious and conscious patterns in their drawing behaviors. However, after conducting initial observations, I had to make adjustments. I decided to have the same participant experiment with three different media: a non-screen graphic tablet, an iPad, and a regular notebook. This approach gave me a better picture of how the devices were being used, as it allowed the participant to talk about their preferences and critiques regarding each medium directly. I used this approach as upon doing the initial inquiry I realized that most of the artists that started out with Wacom tablets had switched to iPads. I also wanted to understand why they switched and what their thoughts were on both devices.

What I learnt from this method

I conducted this CI with four users—comprising 1 professional, 2 amateurs and 1 beginner to observe how each participant interacted with different drawing mediums. Initially, each user was asked to create a drawing using a non-screen tablet, then repeat using an iPad, and finally move to traditional paper. This progression allowed for a detailed comparison across mediums, which was instrumental in identifying key gaps and potential problem areas in user interaction.

From this inquiry, the overarching themes found were:

A. Users struggled initially to adjust to the pressure sensitivity of the digital pen, requiring multiple attempts to become comfortable.
B. Even long-term users of drawing software like Photoshop experienced frustration when adapting to the mechanics of a non-screen tablet.
C. New users found the requirement for hand-eye coordination particularly challenging and vexing, as they had to adapt to looking at one surface while drawing on another.

D. Both beginners and professionals were not fully utilizing the capabilities of the drawing software, indicating a gap in either knowledge or interface design.
E. Users mentioned that they had to keep using it over and over for at least a month to learn the basic functioning of the tablet and somewhere close to a year to actually master it.

This method helped narrow down the problem space into major categories:

1. Helping the user get comfortable with the software.
2. Helping the user get comfortable with the product

4. Secondary Research

The secondary research was done in parts. I tried to read more papers everytime I felt stuck and confused of what direction to move forward in. At the very beginning of the project, I used the Wacom tablet I had and tried to understand, its basic functionality and the different working parts of the tablet.

3.1 Breakdown of the Wacom Tablet

Being the first brand to make digital art more affordable and accessible, Wacom tablets are at the forefront of digital drawing tablets. Talking to various artists I learnt that they rose to popularity way before drawing on iPads became the go-to and have maintained their popularity in the drawing community. Wacom tablets also have a wide range of tutorials available for artists at all stages of learning the skill.

To better understand the functionality I tried to use the tablet myself and make a note of the problems I faced. I also looked into the technical functionality of the tablet. I read through the r/wacom Reddit thread and went through available user manuals to get a deeper understanding of the product.

Drawing Tablet

Wacom utilizes screen mapping to enhance the usability and precision of their tablets to create user experiences that feel as natural and responsive as traditional drawing while providing the digital benefits of undo, layers, and a vast array of digital tools.

Fig 3. Working of a Wacom Tablet

What is Screen Mapping?

Screen mapping is a key feature in graphic tablets that aligns the active area of the tablet with the display area of a computer screen. It ensures that a specific point on the tablet corresponds directly to a specific point on the screen. This is useful for precision in digital art and design, as it allows users to see their hand movements reflected in real-time on the screen, just as they would see when using a pencil.

How Wacom Uses Screen Mapping

Absolute Positioning:

This means that each point on the tablet is mapped to a corresponding point on the screen. This method, different from the relative positioning used by devices like a mouse, is crucial for detailed and precise work.

Proportional Mapping:

Wacom ensures that the aspect ratio of the tablet matches that of the screen. This prevents distortion in the artwork, maintaining the natural proportions and alignments as intended by the artist.

Customization:

Wacom offers extensive customization options for screen mapping, allowing users to configure their tablet to map to the entire screen, part of the screen, or multiple monitors. This flexibility is crucial for users who work across various applications and display setups.

Why Wacom's Screen Mapping is Useful

Intuitive Drawing Experience:

By mirroring the natural action of drawing on paper, screen mapping makes the transition to digital drawing more intuitive. This helps ease the transition from traditional to digital art.

Precision and Control:

The direct correlation between the tablet and screen through absolute positioning allows for extremely precise control. This is essential for professional artists and designers who rely on accuracy for intricate artwork and detailed designs.

Enhanced Workflow:

Application-specific settings allow the screen mapping to automatically adjust based on the software being used. This seamless transition between applications saves time and enhances productivity, allowing users to focus more on creating rather than adjusting settings.

Reduced Eye Strain and Physical Discomfort:

By allowing users to maintain a natural posture and look directly at the screen where the cursor moves in sync with the pen, screen mapping reduces the physical strain often associated with digital art creation.

Drawing Pen

The Wacom pen operates without batteries or wires, using a technology called Electromagnetic Resonance (EMR)

Fig 4. Working of a Wacom Pen

Electromagnetic Resonance (EMR):

Underneath the surface of the Wacom tablet, there is a grid of wires that generates an electromagnetic field. The pen itself contains a coil and a resonant circuit that picks up this

electromagnetic signal. When the pen is brought close to the tablet, the electromagnetic field induces a current in the coil of the pen.

Signal Processing:

As the pen moves across the tablet, the change in the electromagnetic field is detected and processed. The tablet's circuitry calculates the exact position, pressure, and tilt of the pen relative to the tablet's surface. This data is then transmitted to the computer in real time, allowing the cursor on the screen to mimic the movement of the pen precisely.

Pressure Sensitivity:

One of the key features of the Wacom pen is its ability to detect varying levels of pressure. The tip of the pen is pressure-sensitive, allowing it to register different pressure levels as the artist presses harder or softer against the tablet. This capability is crucial for varying line thickness, opacity, and even texture in digital artwork.

Why Wacom's Drawing Pen is Useful

Natural Drawing Experience:

The combination of EMR technology, pressure, and tilt sensitivity allows the Wacom pen to provide a drawing experience that closely mimics traditional drawing. Artists can achieve a high level of detail and control in their work.

No Need for Batteries or Charging:

Since the pen is powered by the electromagnetic field generated by the tablet, it does not require batteries. This not only makes the pen lighter and easier to handle but also eliminates the need for charging or battery replacement, ensuring that artists can work uninterrupted.

Customization:

Wacom pens come with customizable buttons that can be programmed to perform specific actions, such as undoing a step, changing tools, or accessing menus. This

customization enhances workflow efficiency by allowing artists to adapt the tool to their personal workflow.

Ergonomics:

Wacom pens are designed to be ergonomically comfortable, reducing hand fatigue during long drawing sessions. The design of the pen, combined with its lightweight nature due to the lack of batteries, makes it an excellent tool for both casual users and professionals.

This information helped me better understand the working of the tablet and also gather data to help support the argument of why artists should prefer getting a Wacom tablet over an iPad.

3.2 Exploring Experimental Solutions to reduce the learning curve

For this part I went through papers looking for how the problems is being tackled currently and if there are any experimental solutions that have been tried and tested and what I could take away from them. At this point, I wanted to just get a general idea of how I could ideate potential solutions as this space is pretty new to me. I used keywords such as “digital drawing tablet”, “digital tablet input”, “ergonomics in digital drawing”, “haptic feedback in digital pens” and other similar terms. (I’ve only included the papers I found relevant to this submission’s context in here).

Overview of What I learnt from Secondary Research:

1. Enhancing Naturalness of Pen-and-Tablet Drawing through Context Sensing, Sun, M. et al (2011)

The research paper explored ways to make digital drawing more natural and intuitive. It suggested that by adapting the digital environment to the user's actions—like showing a measuring grid when the pen is away from the tablet or adjusting drawing layers based on the angle of the tablet—users can experience an interface that more closely mimics traditional drawing methods. This insight is particularly relevant for reducing the cognitive load associated with mode switching and menu navigation, thereby keeping the user focused on the creative process rather than tool management.

2. Thumb + Pen Interaction on Tablets, Pfeuffer, K. et al (2017)

This paper introduced the concept of using the non-preferred hand's thumb for additional touch interactions while the preferred hand uses the pen. This study highlighted the potential for enhancing the functionality of tablets in mobile contexts, where traditional support surfaces might not be available. This approach can be directly applied to enhance the usability of non-screen tablets by enabling users to interact more fluidly without shifting hands or adjusting their grip, thus making the devices more versatile and efficient.

3. A GUI paradigm using tablets, two-hands and transparency, Fitzmaurice, G. et al (1997)

Fitzmaurice et al. (1997) discussed a GUI paradigm that utilized transparency and bimanual interactions to minimize UI distractions and maximize workspace. This concept of using both hands in a complementary manner can inspire interfaces that support more natural interactions for non-screen tablet users, potentially making these devices easier to use and learn, especially for tasks that involve complex manipulations such as digital art and design.

4. Sensing Posture-Aware Pen+Touch Interaction on Tablets, Zhang, Y. et al (2019)

Zhang et al. (2019) examined how interfaces could adapt to the user's posture and grip, suggesting that customizable and adaptive UIs could significantly enhance the tablet experience. This research underscores the importance of ergonomic design and adaptive interfaces in reducing the physical discomfort and inefficiency typically associated with the first-time use of non-screen tablets.

5. Perception-Aware Modeling and Fabrication of Digital Drawing Tools, Piovarči, M. (2018)

Piovarči et al. (2018) focused on replicating the tactile feedback of traditional drawing tools through digital means. Understanding and integrating such feedback mechanisms could help in designing non-screen tablets that better simulate the physical sensations of drawing, which could be crucial for beginners transitioning from traditional to digital art forms.

What I learnt from this research and how it helped me

These studies collectively provide a deep dive into how the interaction between users and digital drawing tools can be improved. These are the key takeaways I decided to work with:

It is important to identify user experience pain points and technical limitations of current devices:
The research by Zhang et al. (2019) highlights the importance of ergonomics and interface adaptability, suggesting that many current devices may not adequately respond to the physical posture and grip variations of users, leading to discomfort and inefficiency. Additionally, Sun et al. (2011) imply that the lack of context-sensitive features in existing tablets increases the cognitive load on users, detracting from the creative process.

New features might be needed to make non-screen tablets more user-friendly and responsive to the needs of digital artists:
Pfeuffer et al. (2017) and Fitzmaurice et al. (1997) propose the use of bimanual interactions and a more intuitive GUI that leverages transparency and minimal distractions, which could inspire new features making non-screen tablets more accessible and tailored to the workflow of digital artists. These enhancements could dramatically improve user engagement by making digital tools as responsive and intuitive as traditional drawing instruments.

The development of tutorials or additional tools can help users more effectively bridge the gap between traditional and digital art practices:
The work of Piovarči et al. (2018) on perception-aware modelling and tactile feedback suggests a direction for developing tutorials and tools that simulate traditional art-making experiences. This could help new users of digital tablets feel more at home with the digital medium, easing the learning curve by providing more familiar sensory feedback akin to that of conventional tools.

5. Ideation 1.0

I made it a habit to sketch up different ideas throughout the project phase. While reading the research papers, I often came up with potential concepts that I could move ahead with. Once I finalized the main concepts, I discussed them with my peers and professors and eliminated the ones that didn't make sense and went ahead with the ones that made sense.

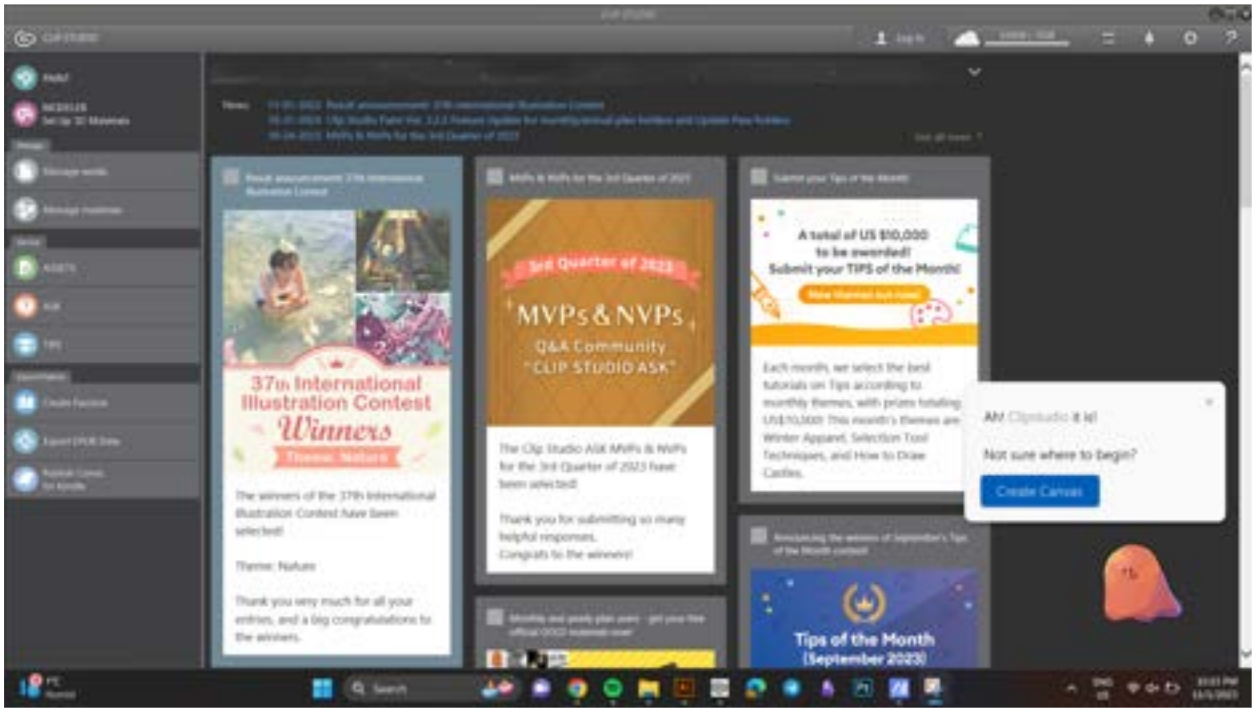
5.1 Approach 1 - Helping users get comfortable with the drawing software

From the Contextual Inquiry, I saw 2 major patterns. The first one is that the users felt like they didn't know the full functionality of drawing software like Photoshop or ClipStudio despite going through all the resources. They felt like even after learning it was difficult to recall all the functionality. They also didn't like drawing on tablets felt so smooth and lacked the texture that traditional drawing gives them. Based on these findings I drew out my initial concepts. These concepts were later rejected as they didn't exactly address the core problem. But I want to include them as discarding these ideas helped me come up with the final solution.

Concept - Digital Assistant

This is a digital assistant, similar to Microsoft's Clippy, designed specifically to enhance the experience of using digital drawing tools. This assistant could be a downloadable extension to the user's laptop, offering real-time guidance and support as they set up and learn to navigate both the drawing tablet and its associated software. This Digital assistant will not only assist users during the initial setup but also provide ongoing support throughout various stages of their digital drawing journey.

I want this assistant to access information from the internet and the software's database to provide timely and relevant tips on utilizing different tools effectively. Most standard product tutorials are typically available only at the beginning of software installation, I want this digital assistant to be accessible whenever needed by the user. This is to eliminate the user from having to rely on searching the internet or watching lengthy YouTube videos to understand a tool's functionality every time they face a challenge.



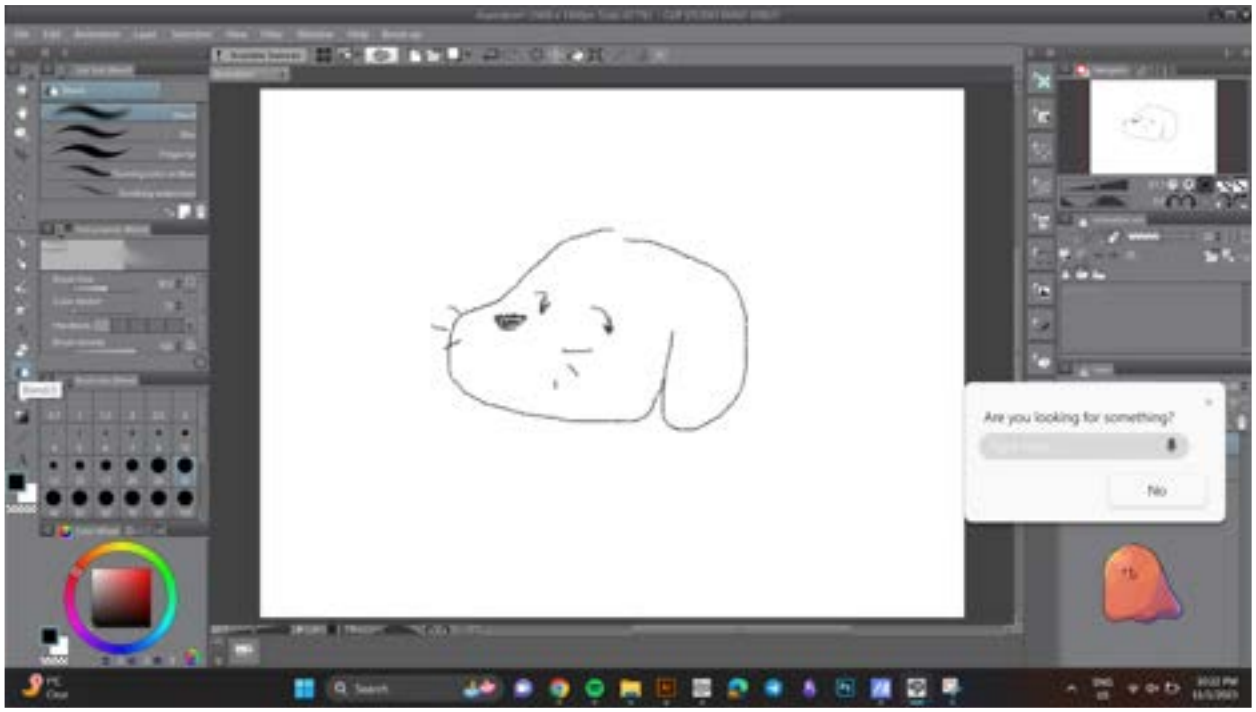


Fig 5. Digital Assistant

Why this solution failed

Although initially it did seem like developing a software aid would be a straightforward solution, but as I delved deeper into the project and discuss it with the faculty, I began to recognize its limitations. This approach, while potentially useful, didn't directly address the core challenge of ensuring users remain committed to using a non-screen graphic tablet. The solution was also inadvertently broadened to become a generic fix applicable to any drawing tablet, which diluted its effectiveness for the specific context of non-screen tablets. This made me stray from the project's goal, which is why I discarded this idea and back to secondary research.

6. Starting over from scratch

When the initial approach failed, I was a little lost on what direction to with the project. The inspiration came to me in a bit of a random manner. While listening to a presentation in class about the user experience of the new PS5 controller, my peers mentioned that Play Station had made an informative game to along with the controller to help the user test out all of its features and also get a better understanding of how it works. I looked further into this idea as it seemed like an interesting concept. Gamyfying the learning process might help sustain users and keep them from getting bored of the repetitive practice that is required to learn how to use a tablet.

6.1 Making Repetitive Learning Engaging

I first tried to get a better understanding of how learning a skill can be gamified. From reanalyzing the Contextual Inquiry, I found out that users had difficulty getting and staying motivated to teach themselves to use a tablet. Most users lost interest after the lack of improvement after a week of practising and abandoned learning the skill altogether. The keywords I used for this set of papers are

1. Learning through Gaming in Times of COVID-19: The Pedagogical Value of Edugames (Viola, I. et al., 2021):

This study examines the integration of educational games (edugames) into digital education systems during the COVID-19 pandemic. It outlines the shift toward digital learning environments and the role of edugames in enhancing cognitive skills like memory, reaction times, and problem-solving abilities. The paper highlights how these games not only motivate learners but also substantially improve their educational outcomes.

2. The Crypt of Notation: Rote Learning through Video Games for Adult Beginner Keyboard Learners (Brett, J. et al., 2022):

This paper presents a novel video game aimed at teaching adult beginners how to read musical notation via an RPG-style game environment. This engaging approach to learning utilizes game-based interactions to make the educational process enjoyable and immersive.

3. Measuring Learning and Fun in Video Games for Young Children: A Proposed Method (Fowler, A., 2013):

Fowler's research proposes a method to assess the educational and enjoyment values of video games for young children, using eye-tracking technology to objectively measure how children engage with game content. This methodology aims to provide concrete data on what parts of a game capture attention and facilitate learning.

What I learnt from this research and how it helped me

The themes presented in these papers emphasize the integration of gaming elements into educational contexts. This method can significantly enhance the learning experiences and outcomes of learning a new skill that requires repetition.

How users can learn through play

The research by Viola et al. (2021) demonstrates how educational games can significantly boost motivation and enhance cognitive skills like memory and problem-solving. Inspired by this, I can create interactive tutorials or games on non-screen tablets that not only make learning the fundamentals of tablet use more enjoyable but also help in reducing the

intimidation factor for new users. The idea is to transform the learning process into a fun and engaging experience that encourages continued use and exploration.

Similarly, Brett et al. (2022) illustrate how video games can be effectively used to impart complex skills such as musical notation in a way that is both immersive and enjoyable. By integrating these skills into interactive challenges or story-driven gameplay, the educational experience can captivate the learner's interest, making the learning process not just informative but also engaging. This approach ensures that users are not only learning practical digital art skills but are also enjoying the process, which is crucial for sustaining engagement and facilitating a smooth transition from traditional to digital art forms.

6.2 Getting a better understanding of how PlayStation did it

In November 2020, the PlayStation 5 launched a feature called Astro's Playroom, a video game pre-installed on the console. This game was made as a tech demo, introducing players to the new controller's capabilities through engaging gameplay. As players progressed, they experienced the controller's haptic feedback and adaptive triggers, showcasing the full range of the console's graphical prowess and interactive potential. The game was highly effective, receiving positive feedback for how it seamlessly educated users on the console's features through interactive play.

Drawing inspiration from this, I came up with a similar concept that can be implemented for the Non-Screen Graphic Tablet. The tablet could include a pre-installed video game designed specifically to familiarize users with the device. Instead of focusing solely on teaching digital drawing techniques, this game would concentrate on helping users understand and master the using the tablet and pen. By engaging users in game-based activities the game aims to build muscle memory and reduce the initial challenges faced with hand-eye coordination.

7. Ideation 2.0

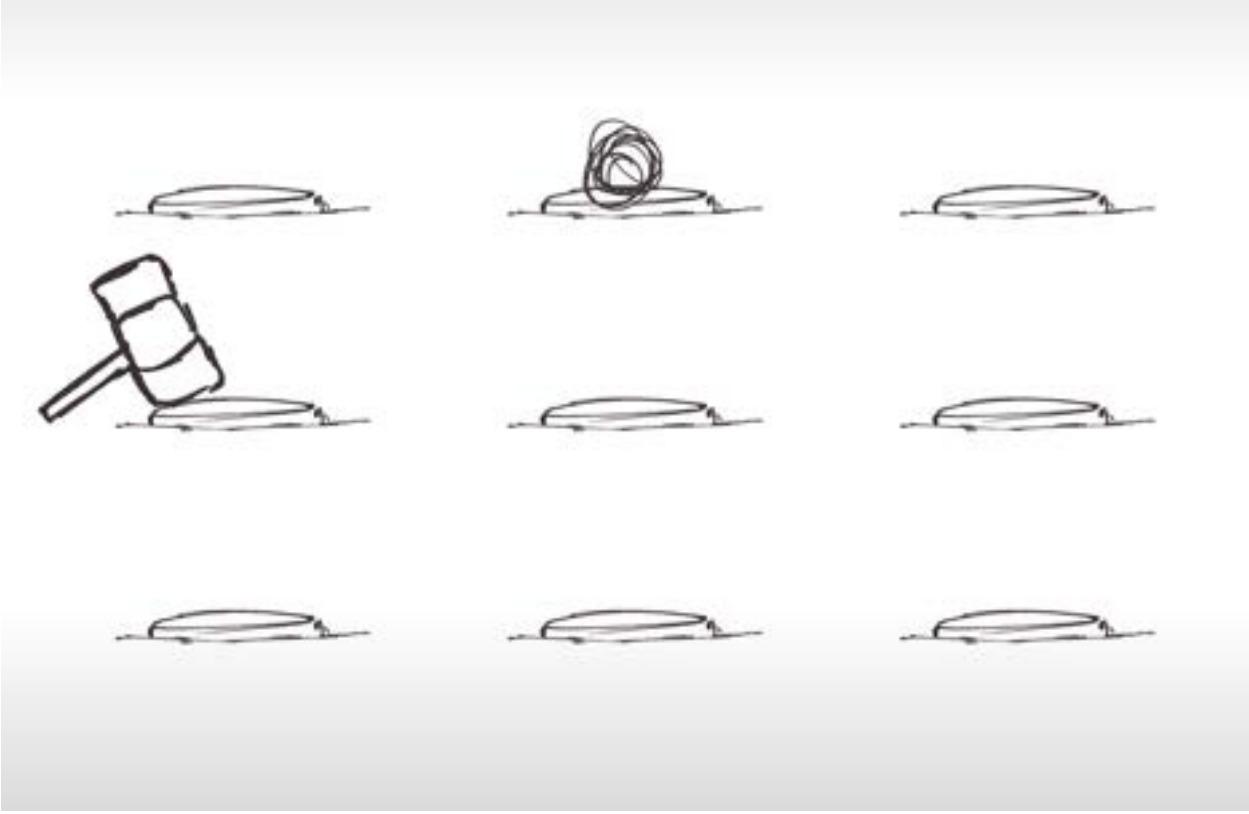
The user is presented with a tech demo featuring three games, each highlighting different functionalities of the device. These games are adapted versions of familiar ones, tailored to showcase the capabilities of a drawing tablet. By leveraging games the user already knows, the aim is to encourage them to keep their focus on the screen rather than constantly glancing down at their tablet. This approach facilitates the development of

muscle memory and eases the transition, minimizing the discomfort associated with the initial lack of hand-eye coordination.

Game 1 - Familiarizing with the Drawing Tablet's Boundaries

This game is designed to help users become accustomed to the physical limitations of the drawing tablet. By engaging in interactive exercises that require them to move their pen within the tablet's confines, users can develop a spatial understanding of their workspace.

In this game, reminiscent of Whac-A-Mole, users are challenged to tap on targets scattered across the screen using their digital pen. As they move the pen around the tablet surface to hit each target, they gain a practical understanding of the tablet's maximum reach. This interactive experience enables users to internalize the dimensions of the drawing area, promoting more precise and controlled movements while working on artistic projects.



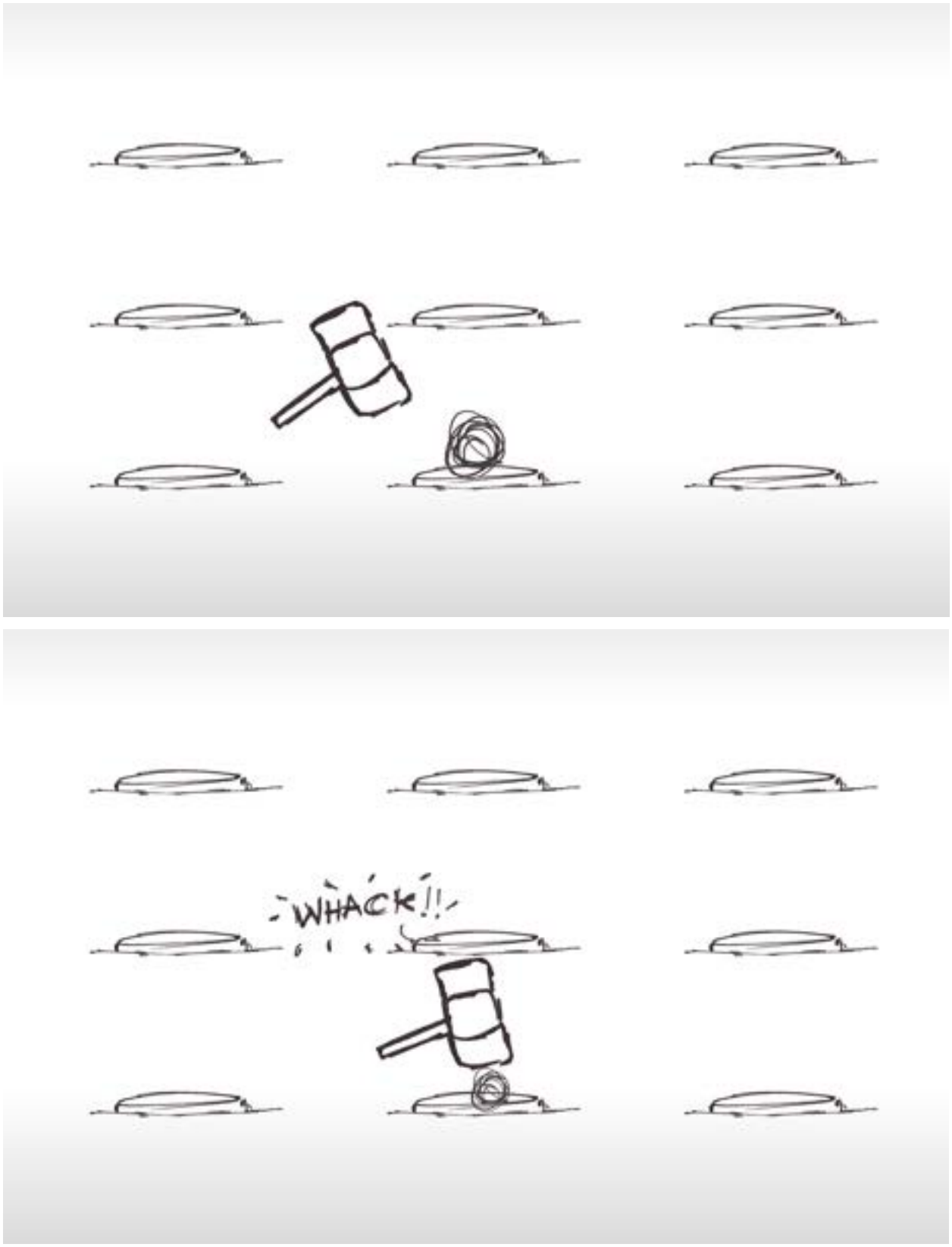


Fig 6. Game Idea 1

Game 2 - Exploring Pressure Sensitivity with the Digital Pen

This game is designed to help users grasp the pressure sensitivity of the digital pen, both physically and visually, through interactive graphical representation. By providing a tangible input and corresponding visual output, users can better comprehend the capabilities of the digital pen.
In this game, users engage by pressing the pen onto the tablet surface to navigate a blob from its starting point to the designated endpoint. The challenge lies in mastering the pressure applied to the screen, as it directly influences the speed and trajectory of the blob's movement. As users experiment with different pressure levels, they observe the strokes generated, depicted by streaks left behind by the moving blob. This hands-on interaction facilitates an intuitive understanding of how pressure sensitivity shapes the artistic process.

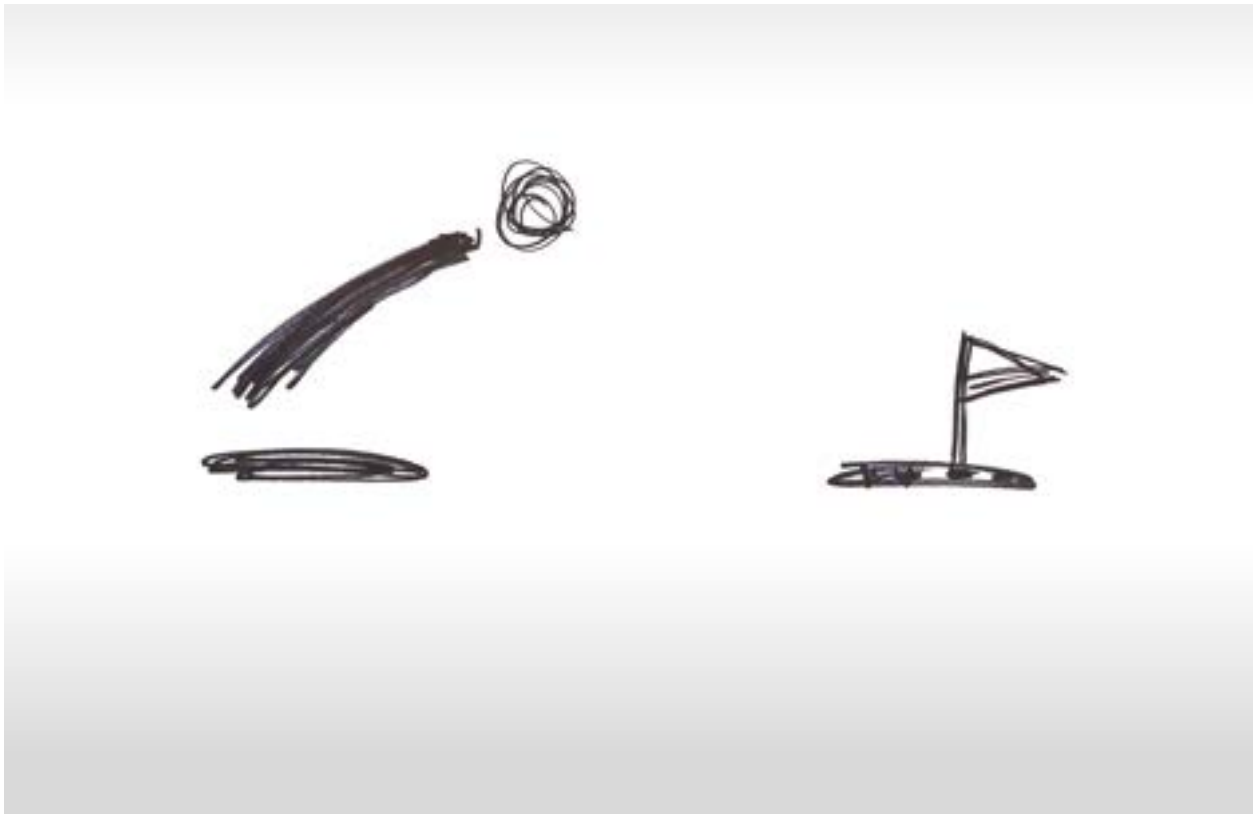
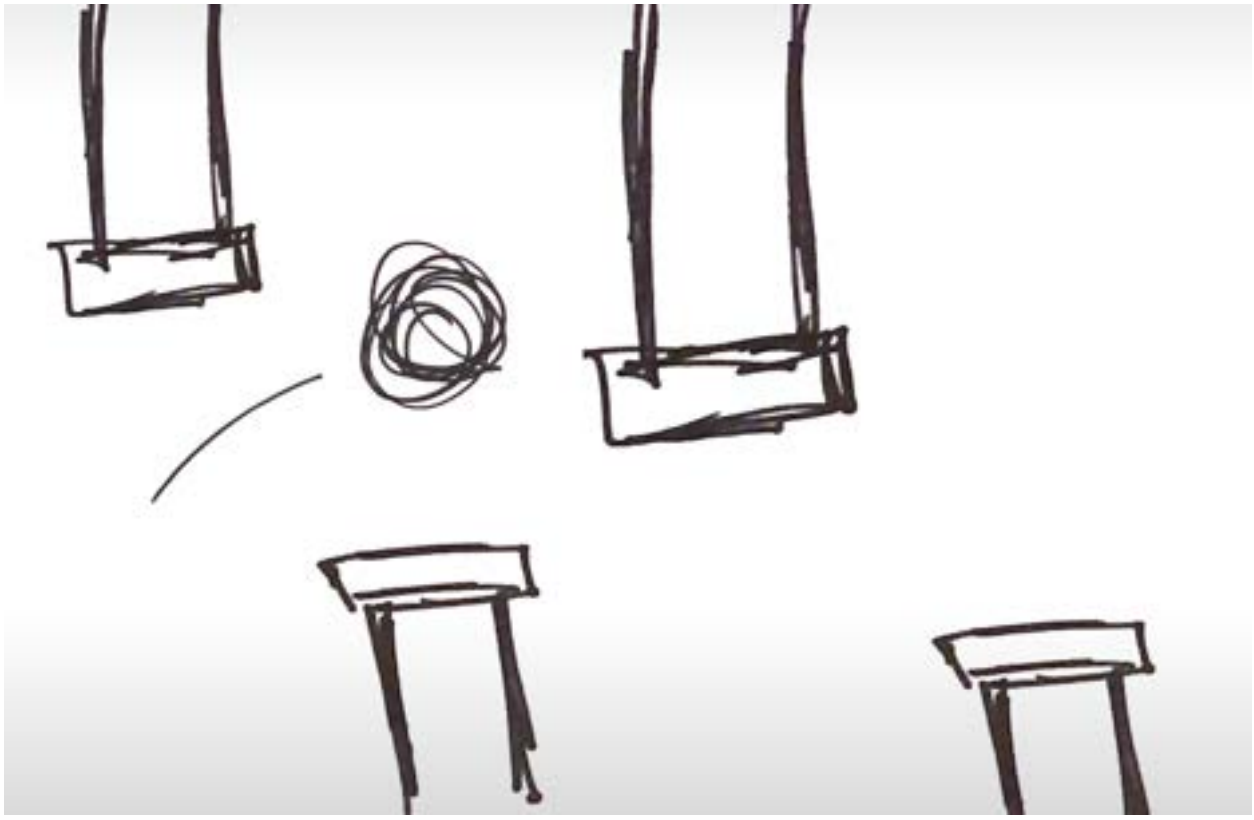


Fig 7. Game Idea 2

Game 3 - Integrating Pressure Sensitivity and Spatial Awareness

In this final game, users will put their acquired knowledge of pressure sensitivity and familiarity with the drawing tablet's physical boundaries to the test. Drawing inspiration from Flappy Bird, this game challenges users to adjust the pressure applied to their pen to control the height of a flying blob while simultaneously manoeuvring it horizontally and vertically to avoid obstacles.

As users navigate the blob through a series of obstacles, they must modulate the pressure on the pen to ascend or descend, simulating flight control. Additionally, they'll move the pen both horizontally and vertically to guide the blob safely through the challenges. By combining pressure sensitivity with spatial awareness, this game serves as a culmination of the user's skills, ultimately preparing them for smoother and more intuitive drawing experiences.



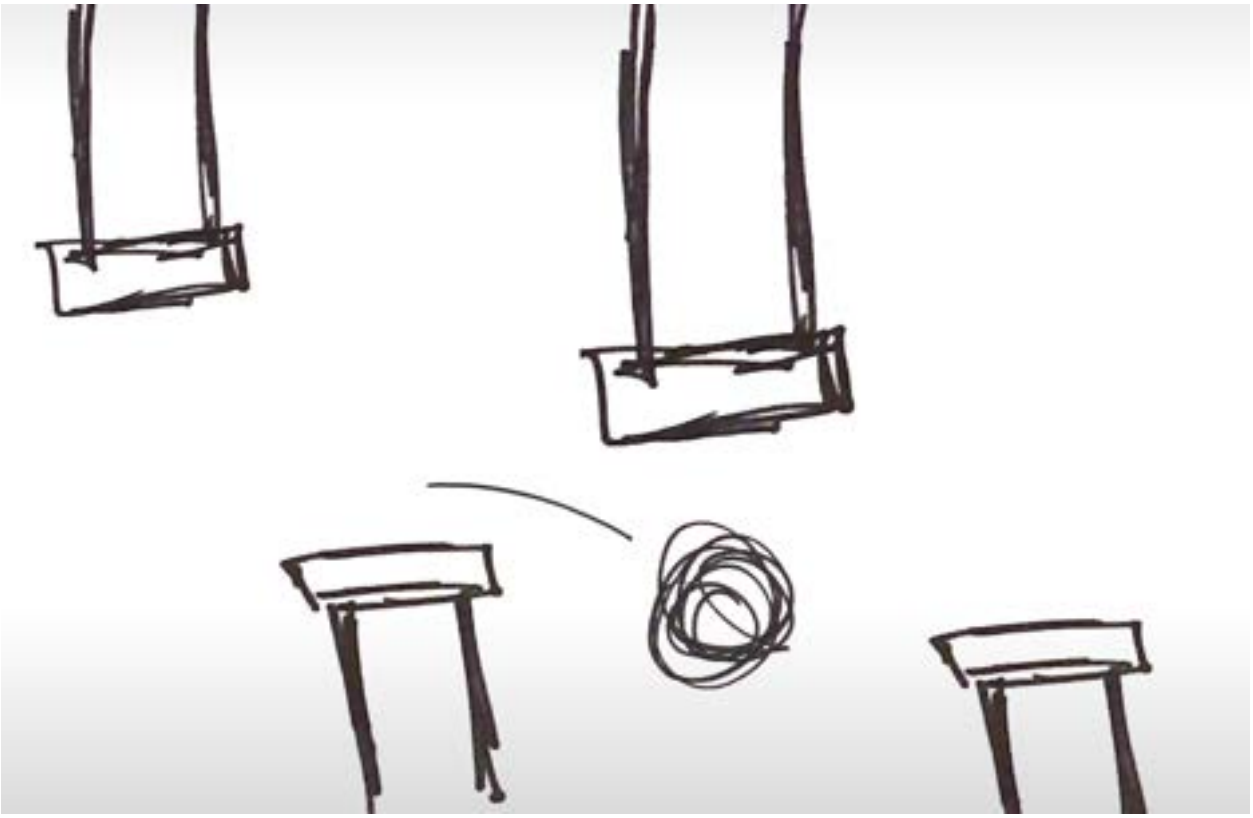


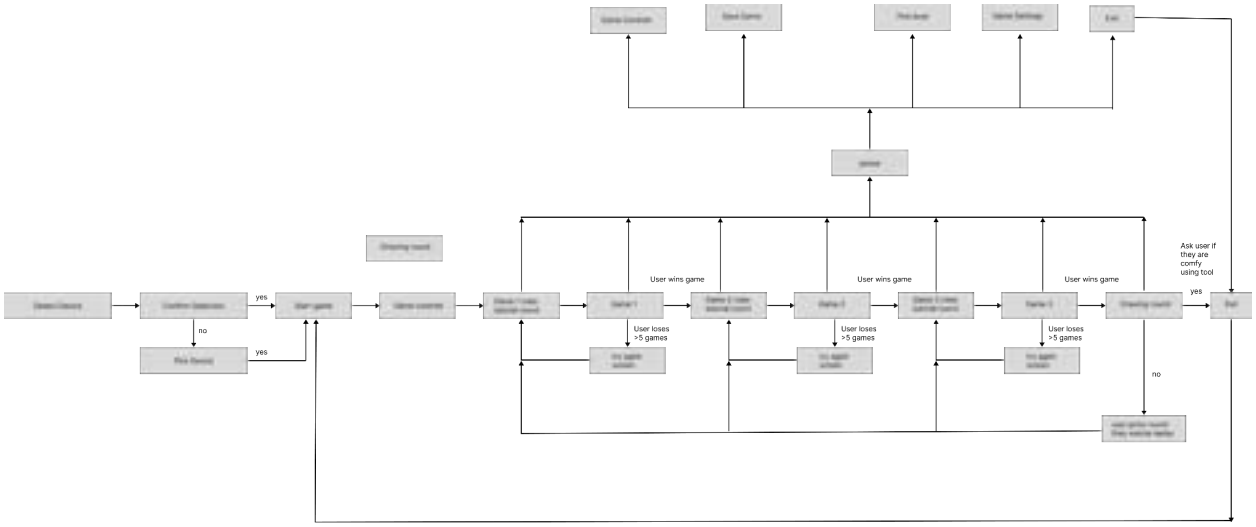
Fig 7. Game Idea 3

I started by making a rough prototype to explain the functionality of the games and what actions I'm trying to make the user get used to it. When I tested these prototypes with both users and peers, I learned that they did like the basic idea of it but at this moment, the game still lacked context and seemed a little scattered. They suggested adding a storyline to bring it together.

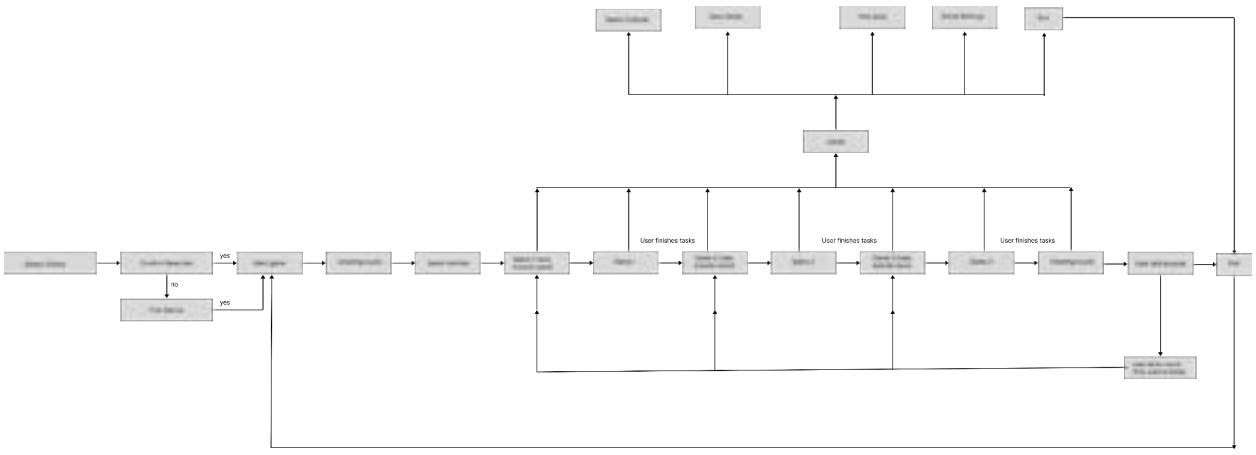
8. Paper Prototyping

To make the paper prototypes I first had to make the structure or the flow of the screens. I tried to imagine all the screens involved and how they would be connected to each other. I also tried to think of what functions the users might expect from the game to be considered a "good game" For the first flow I came up with, the device model gets detected by the game after which the user is prompted to draw the given prompts. This is done to get a sense of how comfortable the user is with the tablet. The game takes this into consideration and the game's difficulty level is set accordingly. The user would have to go through the set amount of levels before progressing to the next one. At the end, the user is asked to redraw the initial prompts and see for themselves the progress they made At the

end they get an analysis of how their skills fare and where they can improve. Once users go through the game in chronological order, they can go back to specific levels to improve specific skills. [Here is a link to the image for a better view.]



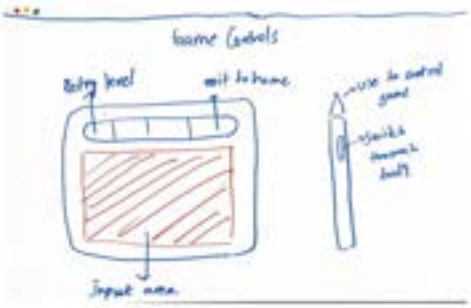
The feedback I got on this flow was to consider that maybe if a user isn't allowed to progress further if they don't master the first skill, it might cause the loser to lose motivation and quit the game. I was suggested to let the user have continuous play. I implement this idea by eliminating levels and instead having a story play where the user has to finish tasks specific to the skill to progress to the next level. They are not tested on them and are allowed to fail the level as many times as they want to. Progress is made by following the plotline. At the end, they get an assessment to see what areas they can improve on. They are prompted to go back and do that specific part over to see how the assessment changes. [Here's a link to the new flow.]



Once I had the flow down I made paper prototypes for the screens from detecting the device to the user playing through the games. I tested this with 3 users and was told that the game makes sense but they still feel disconnected. Making figma prototypes and having the user play these using a tablet might elevate the experience.

The application tries to detect the device the user is using when its connected.

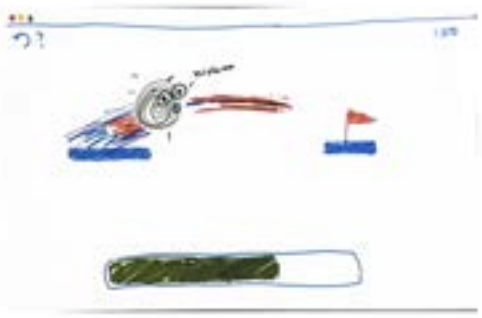
The application detects the device and asks the user to confirm if it got it right.



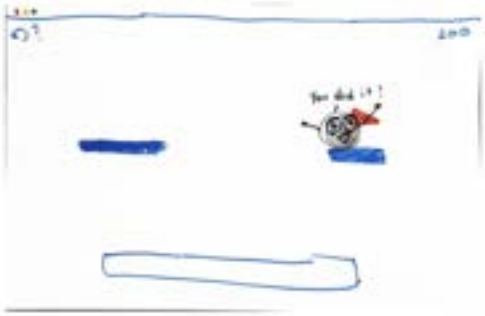
The application tells the user how to use the controls on the tablet and pen to play the game.

The application gives the user an overview of the rules of the game.

The game begins and the user is given a prompt on how to start. The user has to press down on the tablet with their pen.



Depending on how hard of lightly the user presses down on the tablet the ball travels across the screen.



If the user can make the ball land of tje platform they win.

Once the user plays a couple of rounds they can move on to the next round.

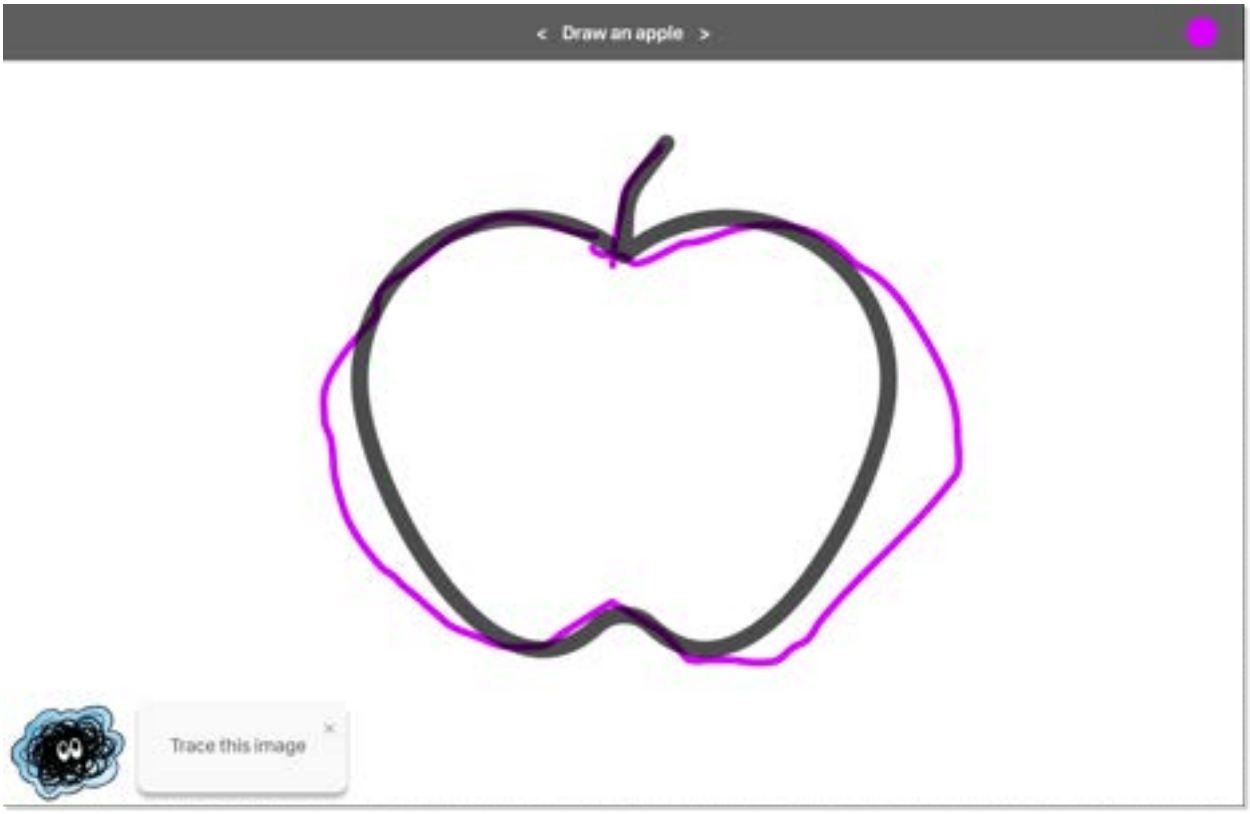
9. Figma Prototyping

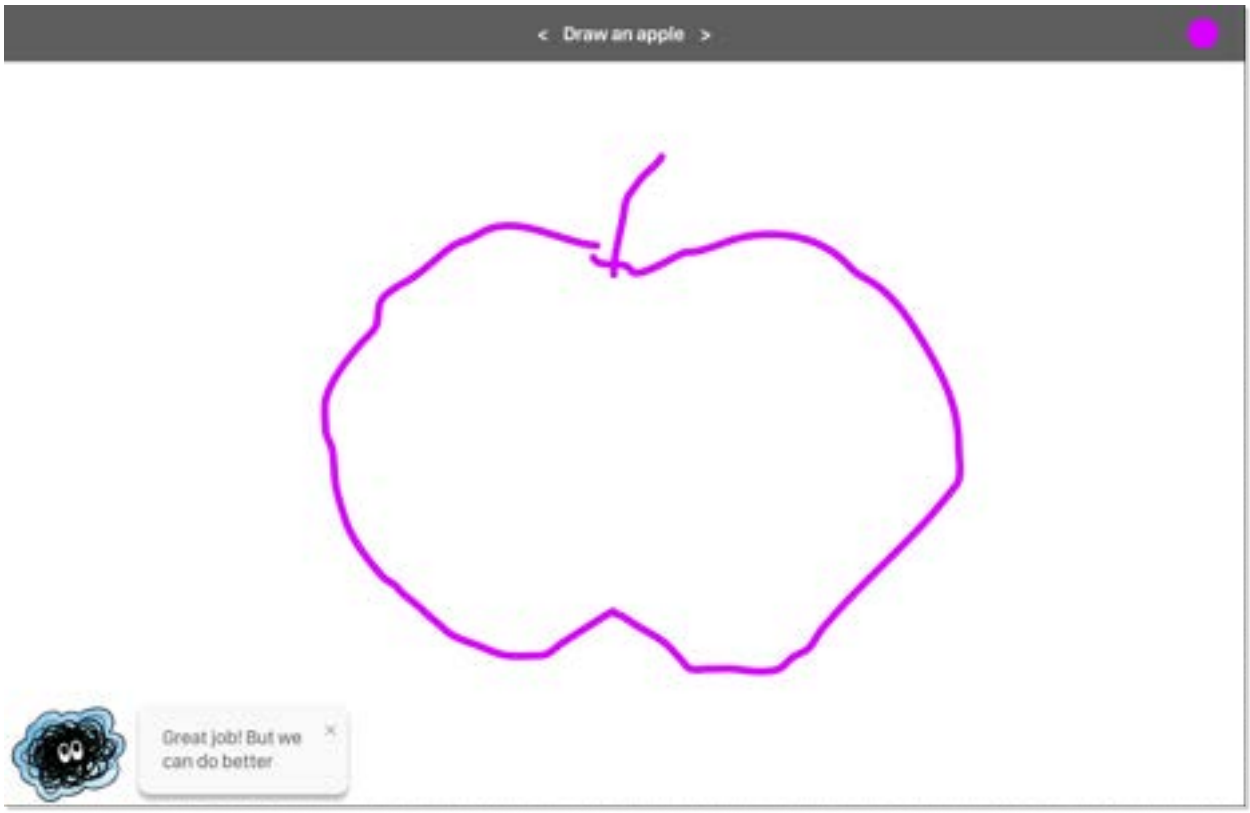
To create a plotline to connect the screens, I designed Scribby. Scibby or Scribble Pet is the main character of the game. The player given the scenario to imagine being an artist working on the project. They're prompted to trace images which help the game understand the level the user is at. While drawing the artist hears a sound outside and is prompted to go check it out. Here starts the first game. The player has to catch Scribby, give him a bath and dry him.

Figuring out what to make the third game about was a little tough. I came up with 3 ideas and made the users test them out to see which captured teaching the skill best. Here's a Link to the Prototype!

Setting the Scene

On this screen, the user is made to trace 3-4 images. This helps the game and the player understand the current stage they're at. At the end of the game, the player is made to retrace the same images and see their improvement. As the functionality is pretty basic, I kept the screen simple. Scribby is on the screen guiding the player.



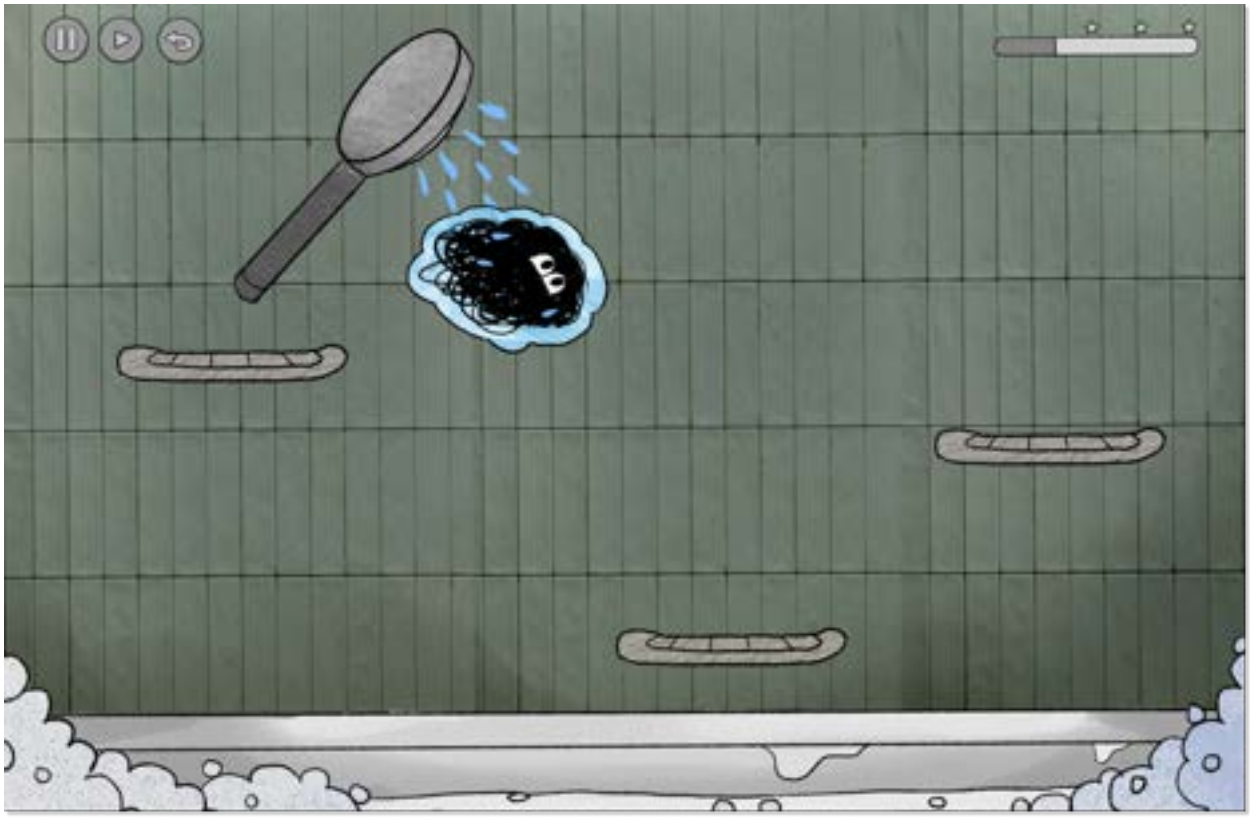

< Draw an apple >
Great job! But we can do better

Find Scibby

This game is designed to find Scribby as he hides at different spots in the scene. As the Wacom tablet surface maps the drawing screen. This game will help the player become accustomed to the dimensions of the drawing tablet and the working space by helping them memorise how far their hand can move while drawing.

Scibby Jump

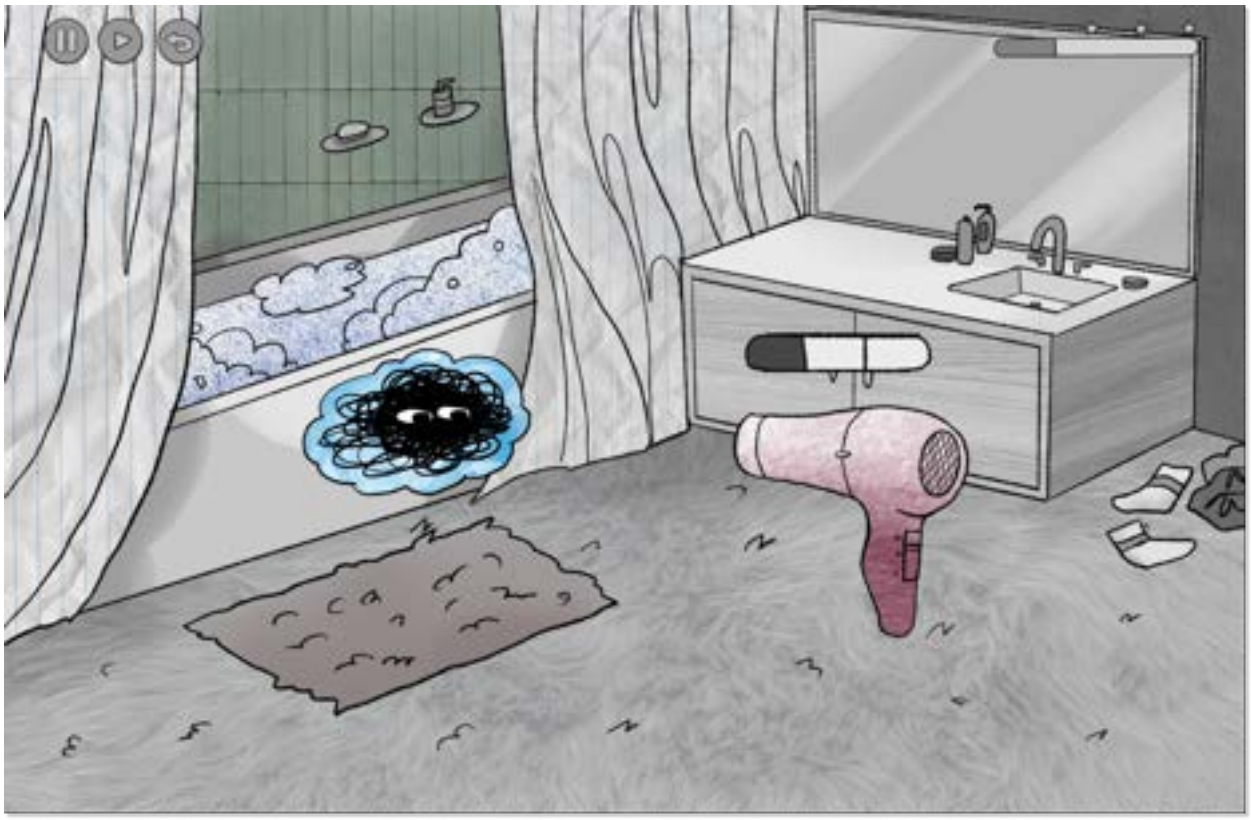
In this game, Scribby tries to run away from the showerhead by jumping from platform to platform. The player controls Scribby's jumping distance by applying different pressure. When the user applies little pressure Scibby can't reach the finish point and the user loses. When the user applies more pressure Scribby can reach the finish point and the user scores. This is designed to help users grasp the pressure sensitivity of the digital pen which is a crucial skill to learn to control brush strokes.

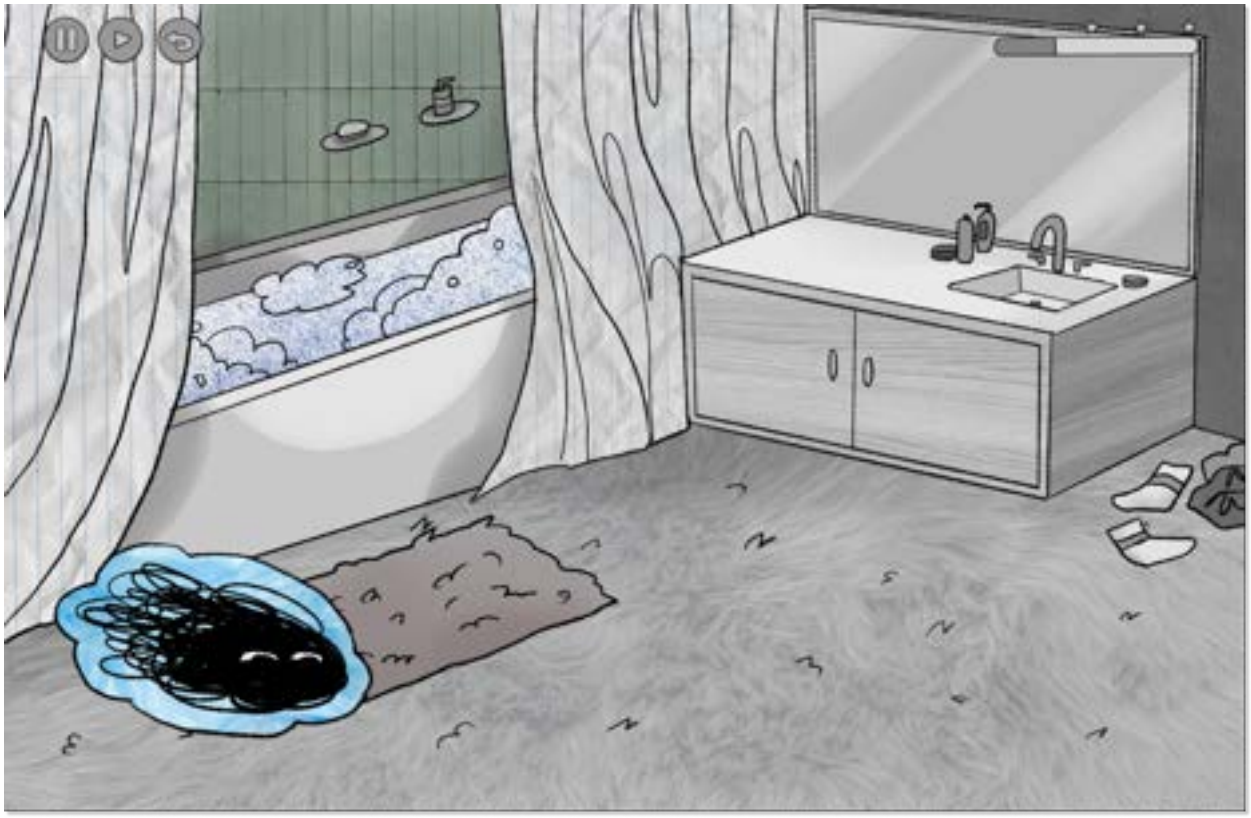



Let's dry him!

Scibby Dry

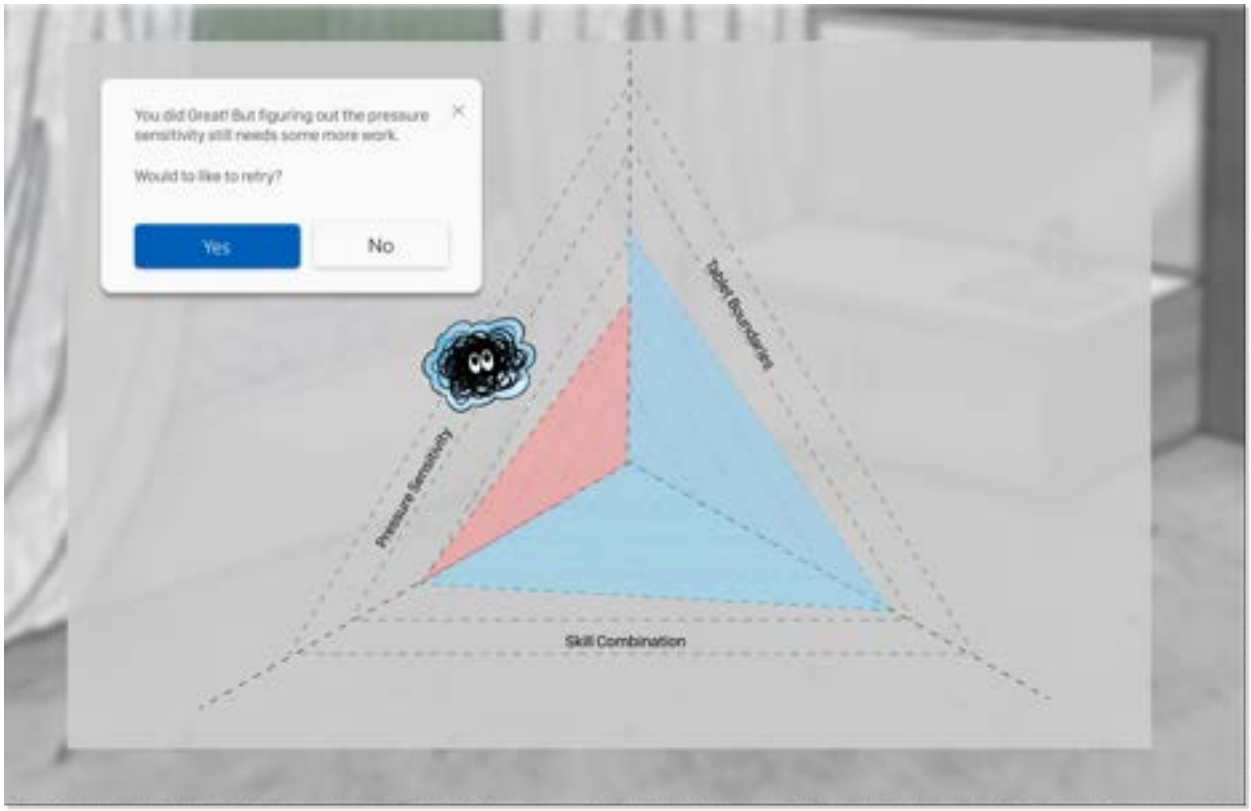
Once the user has mastered understanding the Pressure Sensitivity of the Digital Pen and the Physical Extent of the Drawing Tablet, the final game combines this knowledge and puts the user's skills to the test. The goal is to apply the right amount of pressure to control the hairdryer. If they press too hard Scribby gets scared and runs away causing the player to chase Scribby down.





Skill Analysis

At the end of the game, the player is given a graph that shows them what skills they're good at and what they need to improve on. The player can choose to go back to the specific game and try again to improve on that skill.


You did Great! But figuring out the pressure sensitivity still needs some more work.
Would to like to retry?
Yes
No
Tablet Boundaries
Pressure Sensitivity
Skill Combination

10. Reflecting on the Process

Getting through this Capstone was especially tough for me. Falling sick during this project was an unexpected occurrence. Having to keep up with submissions while trying to figure out why I was constantly falling sick was taxing. It was new to me and it was confusing to deal with staying in this new place all by myself. The project itself turned out to be fun to work on. When I started out I had no idea what solution I was going to end up with. This was a new feeling to deal with. Not knowing the end result is something I find scary. It was especially hard at the end of 3rd semester when I thought I had an answer only to find out that it was wrong and I had strayed away too far. For a while after that, I actively avoided thinking about my project. I did consider gamification but at the same time, I wasn't a fan of it. Over the winter break, I stayed at my aunt's place. My sister was trying to teach my 8-year-old cousin how to do math through a game. She hated having to do math homework over the break and would find any excuse to give up and do something else. The game idea worked on her and that made me want to read more about gamifying learning and seeing where it takes me.

I feel like I learnt how to be ok with not knowing through this project. At all points of the project, I was confused. I knew why I wanted to do this but I was always confused about the how. Which I feel made it difficult for me to convey my idea during the initial gallery walks. I also learnt how to keep pushing even after hitting a wall. There's always going to be another opportunity that at first might feel crazy but will end up being the best opportunity ever. I'm trying to take this mindset forward when going about the job search, It tough and uneasy not knowing but I'm sure there's an exciting opportunity waiting too happen for me.

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Appendix

Secondary Research

2.1.7 EV-Pen: Leveraging Electrovibration Haptic Feedback in Pen Interaction Wang Q., et al (2016)

Insights:

- Many existing digital pen devices struggle to replicate the authentic feel of a real pen on paper due to a lack of feedback and material properties. Efforts to address this through mechanical vibrotactile feedback have been hindered by unintended shaking during precise operations. The EV-Pen, however, introduces a novel approach by leveraging electrovibration technology to provide precise operations and simulate a genuine pen-on-paper experience. This technology controls electrostatic friction between the pen-tip and the touch surface, offering multisensory feedback with different textures without the disturbances associated with traditional vibrotactile feedback pens. Notably, the EV-Pen prototype delivers haptic feedback solely through electrovibration, eliminating the need for mechanical actuators. As it moves across the 3M Microtouch panel, signals induce an electrostatic attraction force, enhancing dynamic friction and enabling adjustable haptic feedback based on waveform, amplitude, and frequency modulation, ensuring a natural pen-on-paper feel with enhanced user control.

Takeaways:

- Participants in the study appreciated the unique capabilities of the EV-Pen, finding that it kept them engaged during drawing and handwriting tasks. They noted that the haptic feedback improved their control over pen movements on the touchscreen, allowing them to draw and write with ease, ultimately enhancing their user experience, efficiency, and accuracy.
- The EV-Pen utilizes electrovibration technology to control electrostatic friction between the pen and the touch surface, providing multisensory feedback through changes in voltage parameters such as waveform, amplitude, and frequency. This technology offers the potential for three channels of haptic information, and the feedback can be dynamically adjusted as the pen moves on the surface.
- The results demonstrated that the EV-Pen is capable of simulating diverse haptic interactions, including replicating friction between objects, conveying various

textural patterns, and offering different feedback modes and intensities for different touchscreen commands.

- Numerous possibilities exist for enhancing haptic feedback in EV-Pen interactions with GUI elements, such as providing distinct haptic sensations when users drag various file types (e.g., doc, pdf, jpg) on touchscreens. These enhancements aim to enhance user satisfaction and overall experience with EV-Pen interactions.
- The majority of participants expressed positive feedback, noting that interaction with the EV-Pen was more helpful, engaging, and satisfying. They appreciated the similarity between the EV-Pen and physical pen-and-paper interaction, and there is potential to further enhance user experience by simulating haptic feedback modes for various pen types on different types of paper.
- The capacity for multi-point haptic feedback through electrovibration enables the simultaneous use of the EV-Pen and fingers on a single touchscreen, allowing for two-handed operations. This opens up possibilities for combined gross and fine-grained interactions with haptic feedback for both the non-dominant hand using fingers and the dominant hand using the EV-Pen, offering potential for further exploration in future research.

2.1.8 Pen + Mid-Air: An Exploration of Mid-Air Gestures to Complement Pen Input on Tablets, Aslan I., et al (2016)

Insights:

The authors posit that while bimanual input with pen and touch gestures is advantageous on large touch surfaces, its benefits on smaller touch screens like tablets remain unclear, potentially hampered by issues such as screen occlusion and ergonomic constraints. To address this gap, they propose exploring mid-air gestures as an alternative for bimanual input on tablets, an area less extensively studied in existing literature. Four Contextual Inquiries and two workshops were conducted to observe real-world digital pen usage, providing insights into task relevance, non-preferred hand usage for shortcuts, and the necessity for flexible requirements to accommodate individual preferences. The study found that users perceived pen and mid-air input as engaging and fun, suggesting the potential for integrating mid-air gestures into pen-based user interfaces to enhance expressiveness and interaction engagement.

Takeaways:

- In situations where complex operations could be completed with one hand, participants preferred using multi-touch gestures. However, when two-handed operations were required, particularly when opening menus before making selections, mid-air gestures with non-preferred hand (NP) were favored over multi-touch gestures with NP.
- Mid-air gestures with the non-preferred hand (NP) were preferred over multi-touch gestures because they were perceived as requiring less precision and being less dependent on specific spatial positioning. This allowed users to quickly set modes, open menus, and perform similar actions with greater freedom of movement and without the need for precise gestures.

Contextual Inquiry Protocol

Introduction

Hi, I'm Manvita. I'm an HCI/d grad student at IU and I'm working on a project about drawing tablets like Wacom. Non-screen drawing tablets are essential for artists transitioning from traditional to digital art, but they can be hard to use for beginners. My project aims to make these tablets easier to understand and use by studying how they work and identifying the main challenges users face. The task today is to make a piece of digital art. You can pick any subject that you like. As you go through this process, please make sure to talk out loud and tell me what you're doing so I can better understand your process. I would like for you to first draw using a Wacom, then repeat the task using an iPad and on paper.

Background Information:
1. Participant Introduction
  - "Can you tell me a little about yourself?"
  - "What is your profession? How long have you been in this profession?"

2. **Experience with the Product/Service
  - "Have you used a Wacom Tablet(iPad/sketchbook/other tools) before?"
  - "How often do you use it for your work?"

3. Skill Level and Preferences
  - "How would you describe your skill level with this product?"
  - "What tools or features do you frequently use?"

(Note to self : add additional questions if user mentions anything interesting and out of my protocol's scope)

Task Observation

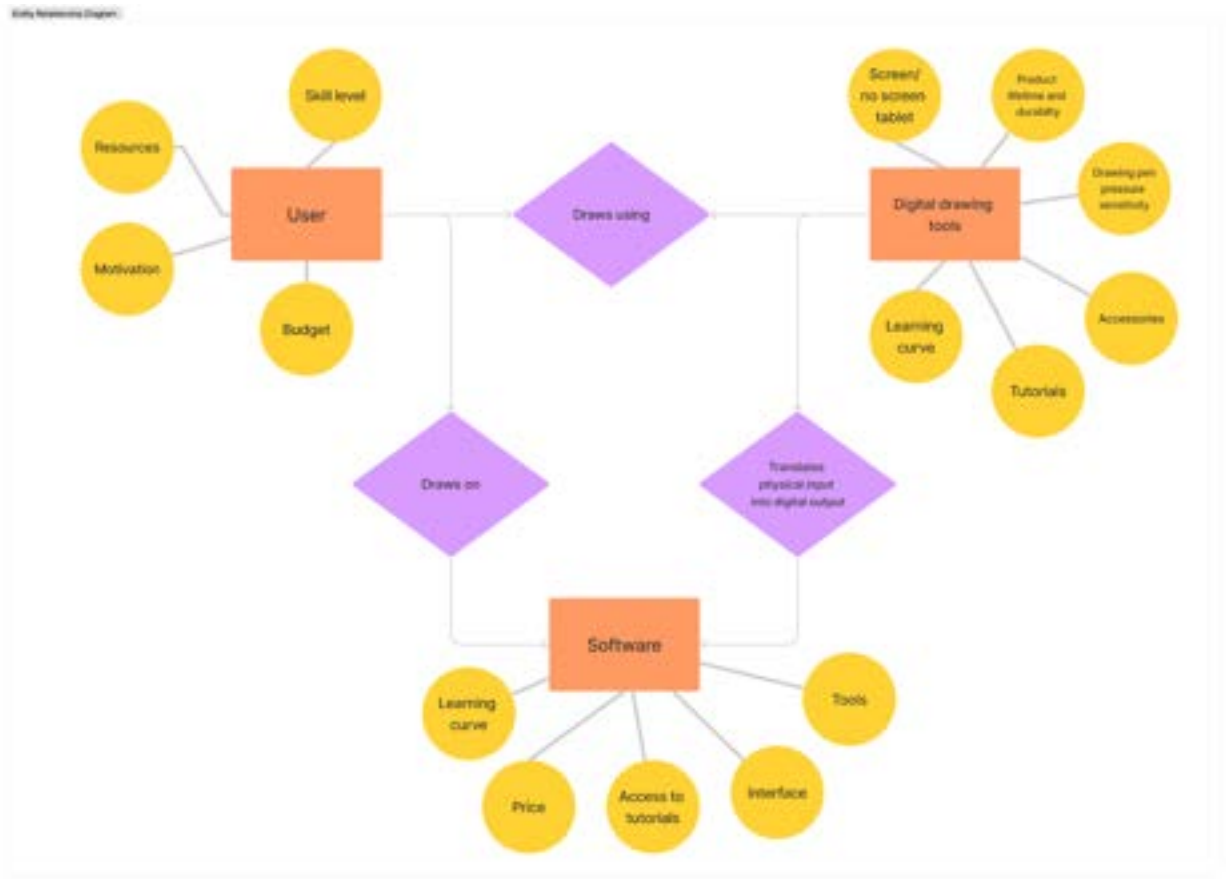
- Observe as the participant performs the task.
- Encourage them to think aloud: "As you work through the task, please describe what you are thinking and doing."
- Ask additional questions if necessary, without leading the participant: "Can you explain why you chose that approach?" or "What are you noticing about (specific feature)?"

Closing Questions

- "Was there anything about the task that was frustrating or difficult?"
- "What did you like about the experience?"
- "Is there anything else you'd like to add?"

Entity Relationship Diagram

The Entity Relationship Diagram was made based on how the user interacted with both the device and the software. This diagram helps understand the kinds of interactions that take place between the user and the device, the user and the software and ‘the device and the software.’

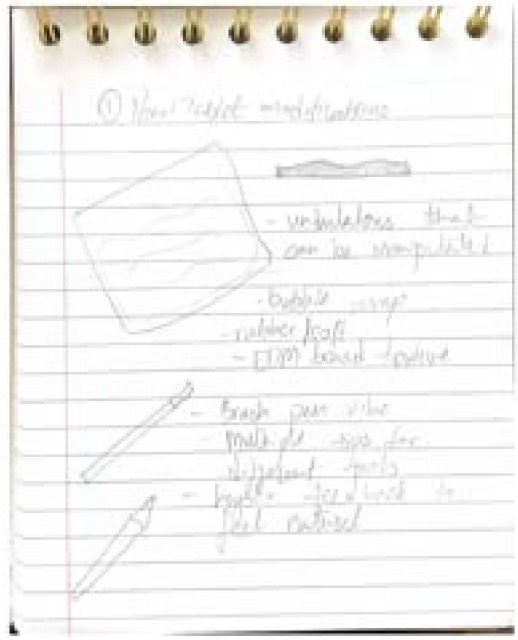


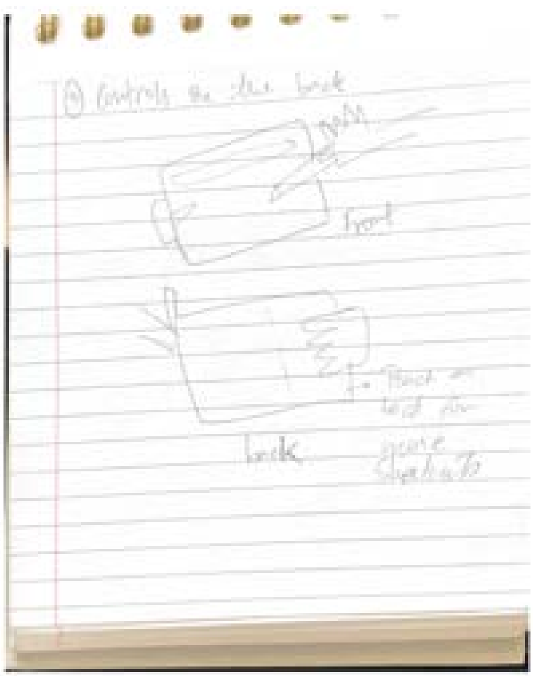
Entity Relationship Diagram of Artist-Digital Drawing Tools-Drawing Software

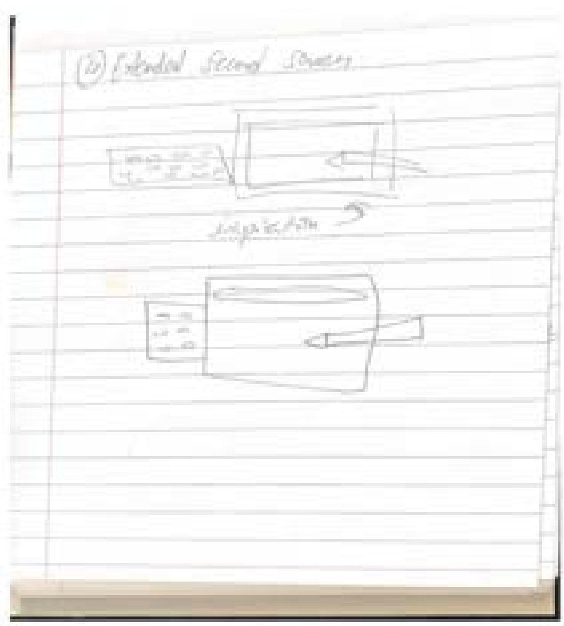
Initial Concepts

Throughout the research process, I tried to sketch out ideas that occurred while I reading the text. Watching videos of users interacting with their drawing tablets also helped ideate. These are very rough ideas that can act as starting points for the potential solution.


Etch-a-sketch
(Grid paper vibe)
- Replace keyboard commands and use both hands on tablet
- Painting with hands brush vibe


- Brush pen vibe
- feel natural


Controls on the back
front
back
shortcuts


Extended Second Screens

Concept 1 - Training Wheels for Digital Drawing

When the user starts using their tablet to draw for the first time, the tablet and software can be set to mimic the roughness and tactile feel of drawing on paper. The device can detect the user's comfort levels with using the tablet and slowly transition from a 'rough' feel to a more 'smoother' feel that's generally associated with digital drawing.

Upon testing this concept with the user, although they did like the idea, they didn't. like that tactile feel fades over time. Some might get used to the 'rougher' style or prefer that entirely over the 'smoother' experience.

Concept 2 - Drawing Nibs

The nib of the digital drawing pen cab be switched out with nibs that mimic different drawing tools such as a paintbrush, or a pencil or an oil pastel. Each nib changes the pen's calibration and gives the user a different tactile feel.

Upon user testing, this idea was rejected as collecting and changing nibs each time the user wants to draw in a different medium can become tedious. The users said that rather than changing nibs regularly, they might as well stick to traditional art.

Concept 3 - Digital Assistant

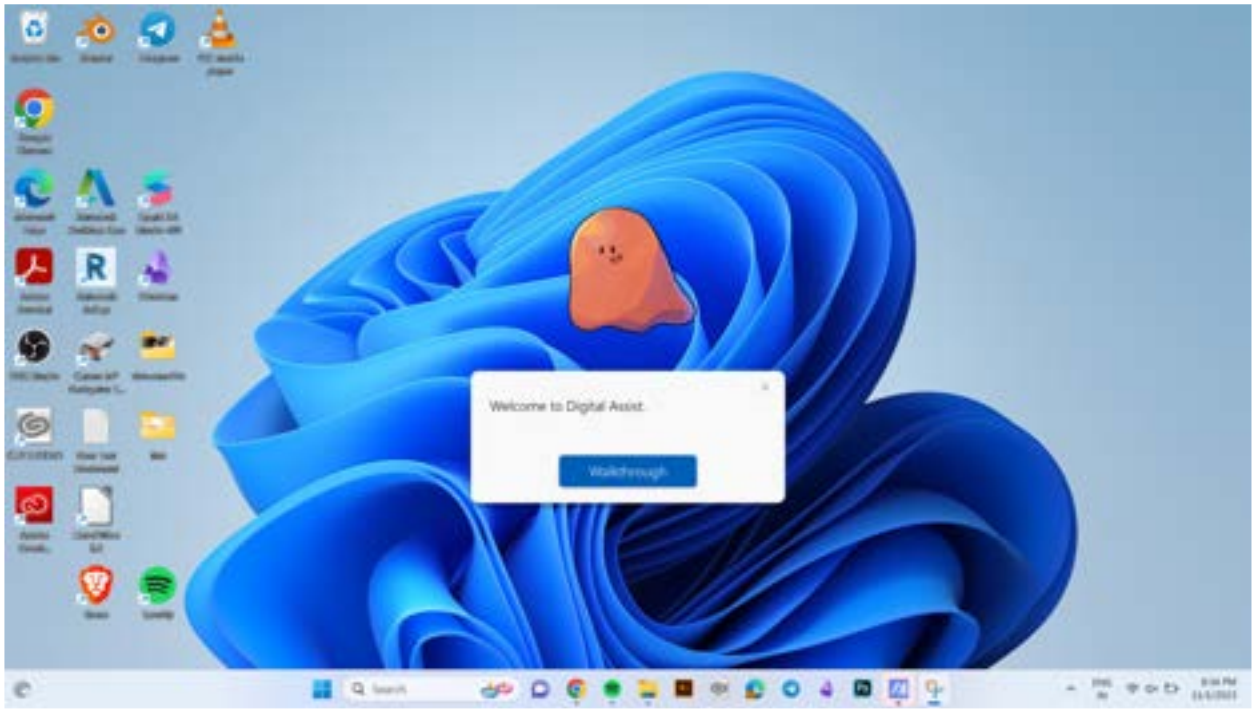
A digital assistant that is akin to Microsoft's Clippy, can be an extension downloaded onto you laptop and help you set up and navigate both your drawing tablet and software. This assistant can help you at stages of your drawing journey and pulls information from the internet and softwares databases to help you find and figure out using the tools you need.

Compare to concepts 1 and 2, the users liked this one as it can also be expanded to other devices and isn't just limited to a non-screen tablet. Product tutorials are often just provided when you first download the software, having an assistant makes it easier to navigate the software and not having to go through the hassle of googling when you forget or having to watch a long youtube video to figure out the functionality of a tool.

Rejected Final Concept

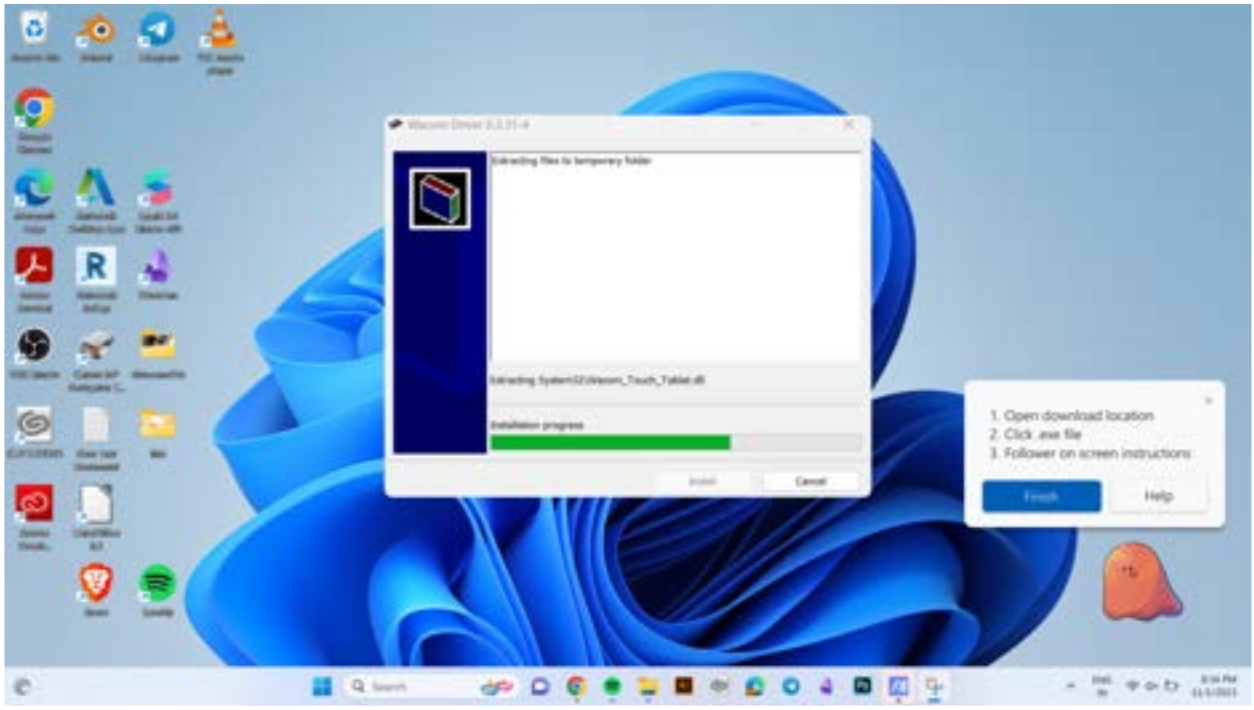
This solution focused on helping the user familiarize themselves with the drawing software. The user is aided with a Digital Companion the likes of Microsoft's Clippy. The Digital Companion takes the user through the installation process and gives them a tutorial of the softwares they wish to use. The Digital Companion is expected to give constant support to the user and evolve it's suggestions with the user's evolving drawing skills.

Scenario 1 - Installation and Device Set up



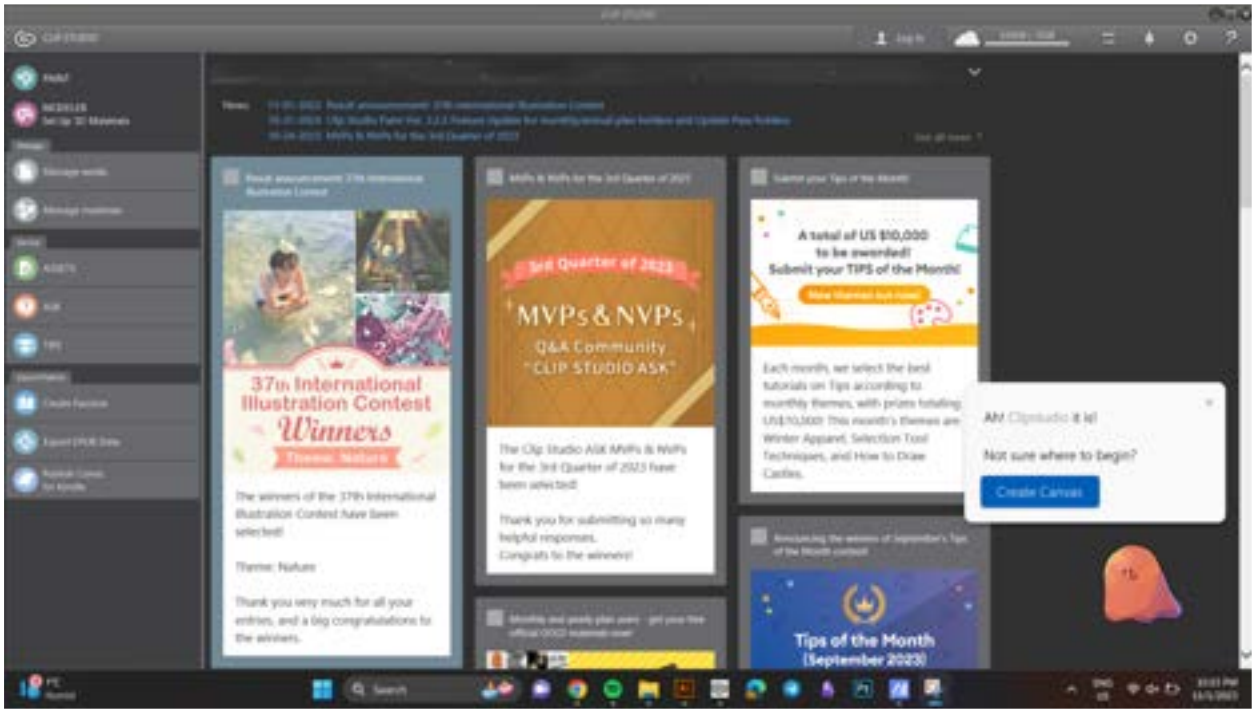
The Digital Assistant comes with a friendly avatar that help you set up your device.

The Assistant detects your device and helps you download the required drivers.

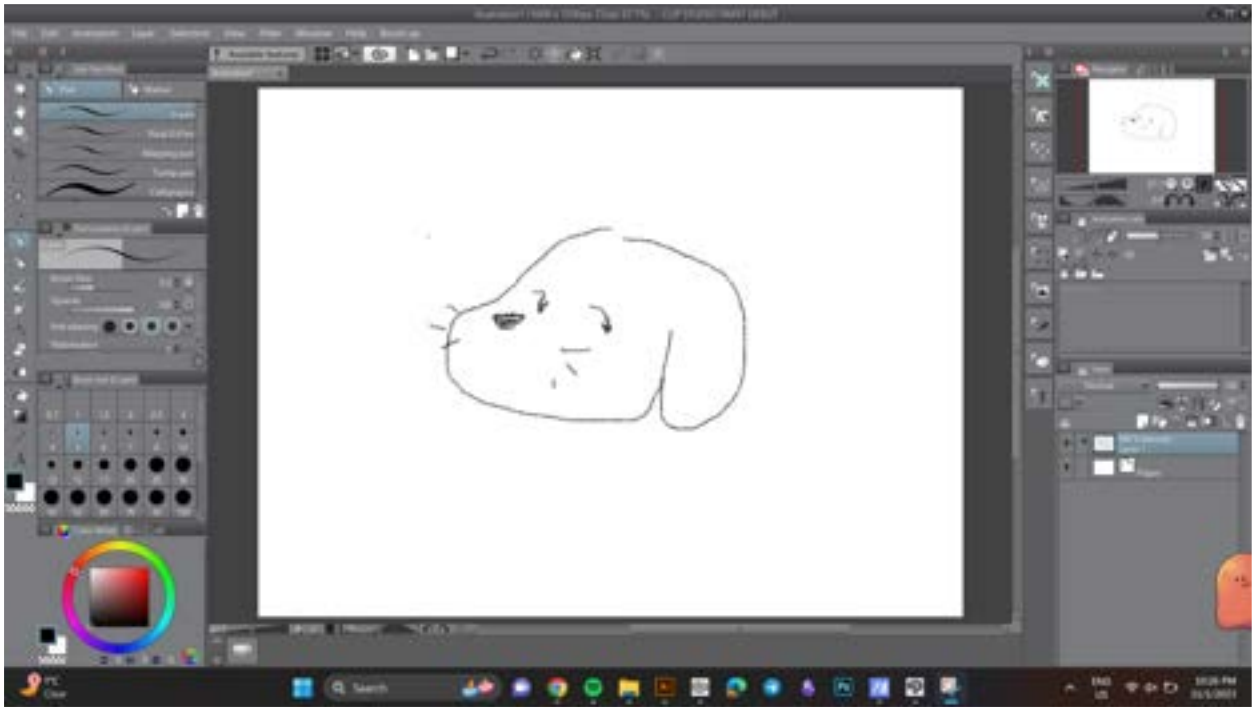


It assists you through the installation process.

Scenario 2 - Using a drawing software for the first time



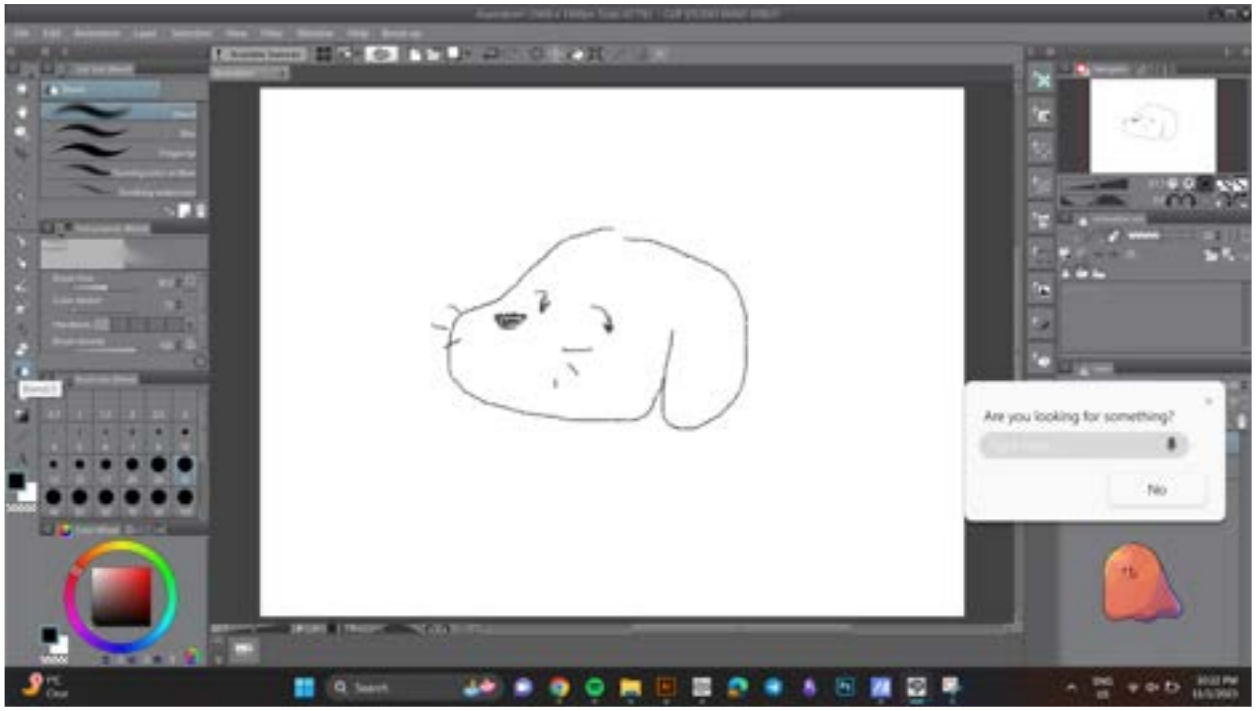
The Assistant detects the drawing software you choose to draw on. It pulls resources from the internet to help you out as you go about drawing.



When not in use the Assistant ‘hides’ in the right corner of the screen and can be accessed by clicking on it.

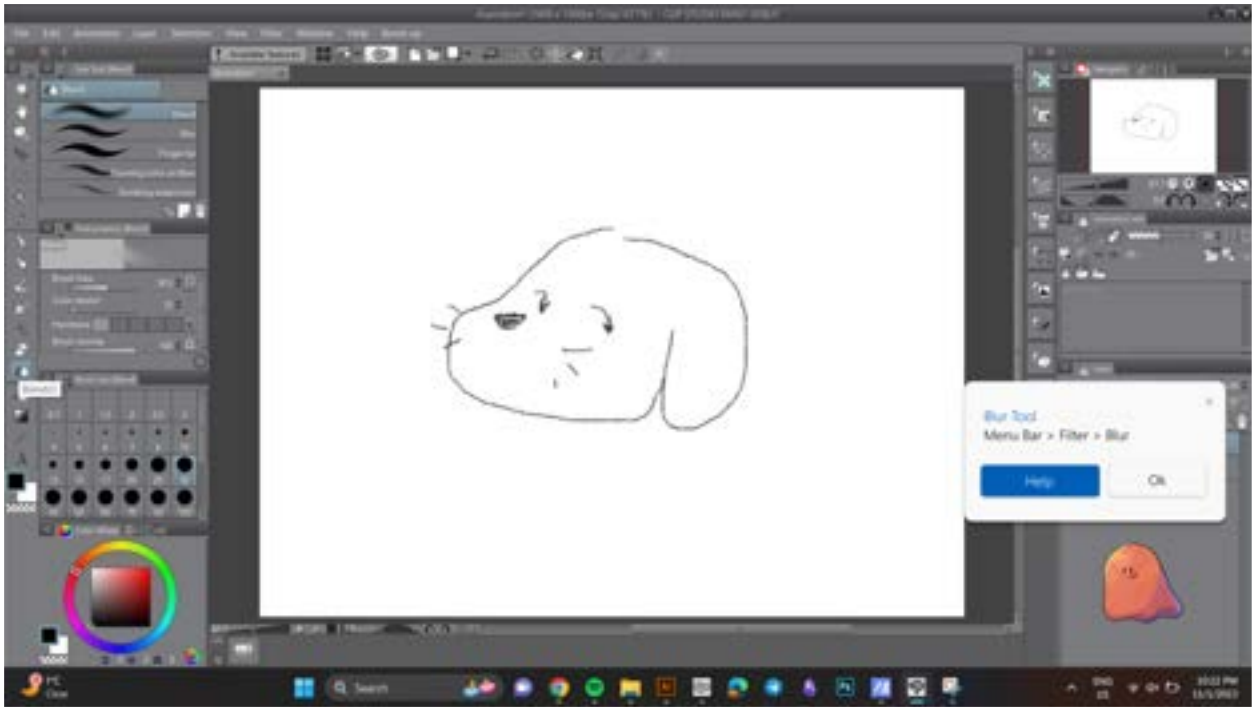
The Assistant helps the user understand the use of the tool and how it can be used in their art.

Scenario 3 - User is confused about a specific tool



The Assistant can also be voice-activated.

Alternatively, the prompt can also be typed in.



The Assistant then helps you navigate to the required tool.

Link to videos of the prototype:

https://drive.google.com/drive/folders/10Up9X8QXqtiCU3oQT0YBDYuE-PRl0p-b?usp=sharing