An Interactive and Collaborative Gaming Platform to Engage the Autism Spectrum in Art Learning using Artificial Intelligence

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ABSTRACT

For decades, mental illness has been a popular topic of discussion that still lingers for effective treatments [1]. While current therapy of mental disorders can achieve success, it is far from enough to prevent their occurrence and impacts on individuals [2]. Because of this, mental illness is an area of study that requires professionals and specialists to take a further step. Additionally, as the use of technology advances in the current society, young children and pre-teens gradually become victims of mental disorders as well: a community that often needs careful attention from adults and caregivers [3]. This paper introduces a method of treating mental disorders in young individuals that is not considered rare, but often overlooked, by many. This application encourages creativity and interests in its users, motivating them to actively engage on their strengths and use it to reflect their struggles.

KEYWORDS

3D Modeling, Unity, Collaborative Gaming Platform

1. INTRODUCTION

Psychology, the study of human mind and behavior, is on the rise to understand the relationship between human emotions and their leading consequences [4]. As our society approaches advancement with developing technology, the romantic side of humans seems to be degraded and bothered. Looking at scientific research, the number of people who suffer from mental disorders is endlessly increasing, While mental illness among teenagers and adults is common and vital, these similar struggles aren't any less significant in the even younger age group. Scientific studies have shown that childhood trauma is one of the main causes for mental illness that follows into adulthood if not discovered and treated by the right time [5]. These mental hardship forces much more pressure on a child than what they are able to manage. Childhood trauma can push individuals to acquire low self-esteem, pessimism, and fanaticism in many aspects of life [6]. These factors can slowly integrate with other struggles that one faces into larger pressure and fear, affecting their lives. Fortunately, the psychology of children's minds is not ignored among scientific scholars, many study the neuroscience behind the topic and conclude their findings. Yet, effective solutions to childhood mental illness are not widely populated as many parents continue to turn to therapy for their children, believing that they will receive fruitful results from it.

Over the last few decades, some medical and psychological techniques have been proposed to parents and children that allow better connections within families, such as the evidence-based treatment (EBTs). There are various types of children therapy that are applied as a treatment to encourage interactions and healing, like the Trauma-Focused Cognitive Behavioral Therapy(TF-CBT) [7]. The TF-CBT aims to heal children who have experienced sexual, physical, and mental abuse by addressing distorted, pessimistic thinkings in children and incorporating family therapy [8]. Its core treatments include psychoeducation, coping skills, gradual exposure to the child's traumatic memory, cognitive processing, and caregiver involvement [9]. All these features of the TF-CBT are used to develop a sense of safety and confidence in the patients. However, these implementations may not be effective to all. Oftentimes, trauma experiencers tend to buried their horrifying past and memories for them to not be reflected on, which is the main reason that can thrawt the the TF-CBT treatment. Additionally, some victim may not be effective to all. Oftentimes, trauma experiencers tend to buried their horrifying past an struggle with financial and educational resources, preventing them to ask for the help they need.

In this paper, we will address our solution to the previously mentioned struggles among young children, and answer the question regarding the scientific prove behind our method. [transition] Before we help, it is important to know how. Several readings that we had done prior to building this program informed us that young children can easily be misunderstood and pressured by others; therefore, finding a relaxing, suitable way of communication is a crucial factor that determines the efficacy of the treatment. Our goal is to provide children a place where they can express themselves freely, without judgement; this aspiration leads us to develop the program, The Drawing Plan.

There are some useful features of The Drawing Plan. First, hearing the name of the app, it is a drawing app. The Drawing Plan is a simple drawing app designed for young children. We avoided having numerous features and functions in the app to "enrich" our user experience and instead stuck with the fundamental drawing functions with only five different types of drawing utensils. This is to ensure that a child can learn how to use the app quickly and without an adult supervision/help, granting them more time and space to work alone. Second, The Drawing Plan provides drawing prompts, randomly and custom-designed. Every drawing prompt is carefully considered to ensure it has its own value in helping the child reveal their struggles. The custom-designed prompt is a function for the caregiver or guardian of a child who desires dedication on a topic, which helps the users to dig deeper into the problem if they have already discovered some information about the child. Third, the user-experience designs of The Drawing Plan are all original creations. We first began the work on paper, sketching for icons and laying details out, then scanning the hand-drawn designs to the computer for further edit, and finally importing our designs into the app to create the finished look. Therefore, we believe that The Drawing Plan will be able to assist both adults and childrens in healing any sorts of childhood trauma and illness.

In two application scenarios, we demonstrate how the above combination of techniques can provide proper help to our users. First, before we begin promoting and launching the application, we run an experiment ensuring the appropriate functions of the application: what does each button do, does the application give immediate response when a button is pressed, is there anything that malfunctions? Second, we introduce this application to audiences as a real-life experiment, analyzing the evolution of an user's thought as they use the application. This includes hosting in-person workshops to engage with young children and physically experiencing the atmosphere of a classroom. The application scenario is the main experiment of our program that relates to child psychology.

One other scientific proof of the efficacy of The Drawing Plan comes from the reading of the book What Happened To You: Conversations on Trauma, Resilience, and Healing. This book

discusses the perspective of individuals whose lives are heavily impacted by trauma, and the results of experiencing childhood trauma and the process of healing from mental disability.

The rest of the paper is organized in an order that will help readers better understand the rhythm and usage of my app. Section Two will give specific details on the challenges that we faced while creating the app. Section Three focuses on the solutions to the challenges addressed in Section Two and an outline of the program. Section Four gives detailed information on the real-life experiments and community services done regarding this application and its related topic. Following that, a series of articles and books written by professional scientists are summarized and compared to the concept of The Drawing Plan. Finally, Section Six addresses the application's potential future updates and corrections.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. Determine a Topic

Being able to determine what program to build was the first challenge that I encountered. Initially, many paths and ideas were laid in front: creating a color mixer for artists, an automatic phone number recorder, a drawing game. All well-inspired and absorbing. Yet, choosing the topic that has practicality, not too difficult to accomplish, and does good to the society was difficult. I carefully evaluated the necessity and functionality of each concept with many things in mind, such as the intended audience of a concept, the difficulties to reach my end goal—a finished program, and whether or not this program will be useful.

In the end, out of all the other ideas that fascinated me, I chose to design a program for children with special needs and/or mental disability. The reason for this is that I'd like to help those who don't often get enough attention and support from others, and are struggling with their daily life at the same time. Those who are thriving to overcome their struggles, parents or children, need their excruciating pain to be eased; but sometimes this is overlooked by others. Therefore, I had decided that making an app that aids this group of population will help the society towards a greater sense of happiness.

2.2. Designing the Visual Theme

The second challenge that I faced was to create the right functions and designs for children. This may seem like it has an easy solution: use cartoons and children-friendly designs. However, with my program's purpose of helping special-needs children, the usage and visuals of my app have to go beyond ingenious. Because of this, I conducted a vast amount of background readings and research about children. I read books and articles about different types of children's psychological struggles, the impact of childhood trauma on a person, children's psychological needs when they suffer from mental illness, and the process of healing. Additionally, it is known that young children don't have complete knowledge of revealing their thoughts to others with words, therefore I dedicated myself to developing a methodology that children favor. The application must encourage the user to be regulated and relaxed, it must not create tension in any way, because negative emotions affect what a child's creative mind can produce.

2.3. Programming Difficulties

The third challenge that I had to embrace was the constant learning of unfamiliar codes and programming stages. In order to ensure users have a fine experience when using this app, my team had to research suitable programming functions and Unity's, what we used to build the app, features and settings for what we needed to establish. For example, it was a challenge when we tried to import brush textures into my program to create a variety of digital drawing utensils for users. We worked with numerous different line codes and explored Unity's own app settings to try to overcome the struggle. Many attempts took place, but most did not reach what we hoped for.

3. SOLUTION

Component/Platform 1 - Free Draw

This application is a child-psychological help program that allows young users to convey their stories and their supervisors to evaluate necessary actions to be taken based on the child's drawing. To ensure whether the quality of this application meets its intended mission, there are three characteristics that I focused on: the clarity of the application's job, the artistic theme, and the simplicity of each branch inside the application.

With the intended users of this application, children and caregivers, the application will provide users with three platforms: the Free-Draw platform, Get-a-Prompt platform, and Make-a-Propmt platform. Each platform has its specially-designed options to satisfy the users' needs. When entered into the app, all users will see a "Start" page with the application's title and a button to begin using the application. The user will then be led to the Main Menu page, and there, they are presented with the three platforms discussed earlier. Each of these platforms is implemented with its own purpose while sharing the same major functionality, drawing. Below are three visualizations of the the platforms.

Figure 1, shown below, is the page upon clicking on the Free Draw button in the Main Menu. Here, a window will appear in the center of the screen with the prompt, "Free Draw". Below the prompt, there is the "Back" button and "Save" button; in the top right corner, there is the "Exit" button to close the window .

On the drawing page, the user is provided with 14 color swatches, including shades of the primary colors, secondary colors, and black, gray, and white. There are also five different types of brushes, including the acrylic paint, crayon, marker, pencil, and watercolor textures. Among the five textures, the watercolor brush performs one special technique: blending. The transparency of the watercolor brush is a perfect tool for mixing colors and creating a variety of shades and values, further enhancing the user＇s work of art. The user is able to switch between any of these features to maximize their creativity.

Figure 1. Buttons in the main menu

Figure 2 below shows the segment of code that establishes each brush mark made on the drawing panel. First, we call the system to instantiate, or create, a "brush". We define the width and length of the brush by looking at where the brush mark starts and where it ends, setting a specific point position for them. Then, we ensure that the color of the brush mark remains the same for one complete stroke. After, the line "layerDistance -= 0.1f" creates a vertical distance between each brush mark, making all of them in separate layers to prevent issues with some brush strokes overlapping with others incorrectly. This, however, will visually appear to the user on screen, every brush mark will be flat.

```
void CreateBrush()
{
    GameObject brushInstance = Instantiate(brush, gameObject.transform);
    currentLineRenderer = brushInstance.GetComponent<LineRenderer>();

    currentLineRenderer.startWidth = brushWidth;
    currentLineRenderer.endWidth = brushWidth;

    currentLineRenderer.startColor = primaryColor;
    currentLineRenderer.endColor = primaryColor;

    currentLineRenderer.material.SetColor("_Color", primaryColor);

    layerDistance -= 0.1f;

    Vector2 mousePos = m_camera.ScreenToWorldPoint(Input.mousePosition);
    Vector3 pos = new Vector3(mousePos.x, mousePos.y, layerDistance);

    currentLineRenderer.SetPosition(0, pos);
    currentLineRenderer.SetPosition(1, pos);

    //currentLineRenderer.material.SetTextureScale("_MainText", new Vector2(100,1));
    //Debug.Log(currentLineRenderer.material.GetTextureScale("_MainTex"));
}
```

Figure 2. Create brush code

Component / Platform 2 - Get a Prompt

The major outline of the Get-A-Prompt platform is similar to the Free-Draw platform. How this platform differs from Free Draw is that this time, it generates a randomly selected prompt for the user. For instance, the prompts can say, "What does your dream birthday party look like?", or "What do you do when you are home alone?". The user then follows the guidance of the prompt to create and visualize their thoughts. After they finish their drawing, they can click on the "Settings" icon located on the top left of the screen to save their drawing. Figure Three is a segment of code that shows the implementation of the random prompt function.

```
public class AppState : MonoBehaviour
{
    public static string[] promptsList = {
        "What does your family vacation look like?",
        "What do you do when they are home alone?",
        "It's lunchtime at school!",
        "Oh no! You forgot to do their homework!",
        "Draw your dinner!",
        "What do you look like in the future?",
        "Your dream birthday party!",
        "Draw you in your favorite clothes.",
        "Draw yourself!",
        "Your least favorite food?",
        "A person and a hand!"
    };

    public static string prompt = string.Empty;


    public static void SetRandomPrompt()
    {
        int count = promptsList.Length;
        int index = Random.Range(0, count);
        prompt = promptsList[index];
    }
}
```

Figure 3. AppState code

Component / Platform 3 - Make-A-Prompt

The Make-A-Prompt platform, presented in Figure 4 below, is designed for the adult user and/or caregiver of the child. The purpose of this platform is to give adult users the opportunity to seek for what they need from the child. This platform is useful when the guardian of the child has already found out some characteristics of the child, and they want to continue their exploration. Here, the user is allowed to craft a prompt of their choice to guide the young child more intentionally. After the user has entered in a prompt, they can click on the "Next" button, the application will again take them to the drawing panel, with a window in the center stating the prompt that they've entered.

Figure 4. Screenshot of feature

4. EXPERIMENT

4.1. Experiment 1

The three platforms designed are strong indications of the purpose and theme of this application: to perform psychological help to a child in need. The application provides indirect aid through the method of drawing to ensure mental regulation of the young users. Design experiment #1 focused on testing the application itself and its proper functions: the drawing panel. We tested the

usage of the brushes and colors in our drawing page to ensure that one of the main functions of this application serves its purpose. The process of this experiment includes launching the application on different devices to test its consistency, and running the application long enough to check its stability. We tested the program on both Windows and Apple devices, such as laptops, PC, iPads, and iPhones of different models, running the application on multiple devices simultaneously.

After a few trials, the result shows that all buttons implemented into the application respond correctly and timely. However, one technical issue was found. The application is able to function properly when multiple devices are running it at the same time, but not for long. Approximately 15 to 20 minutes of using the program, it occurs to some devices that the drawing function freezes and that the user is still able to pick colors and switch brushes, but they aren't able to draw. Figure 5 below compares the number of times the application freezes with regards to time. The only method to solve this problem within the application is to return to the main menu and begin a new drawing. Although there is a "save" button in the program that saves the users' drawings, the users no longer have access to edit their works.
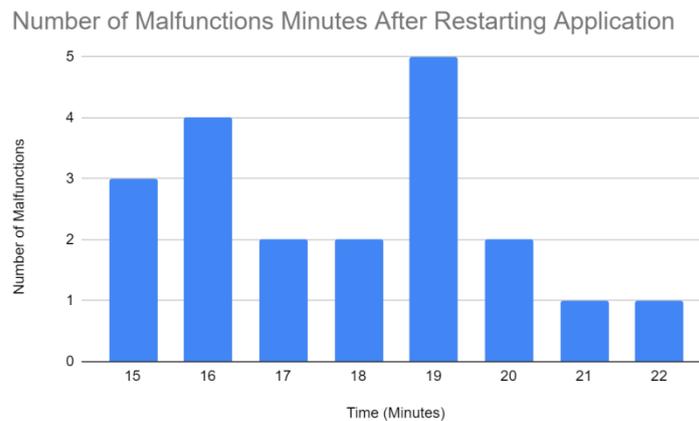

Figure 5. Number of Malfunctions Minutes

It is clear that some technical challenges are still awaiting to be solved in the application right now. A revision of the code is needed for the current version for further, advanced developments in the future. We will need to inspect what causes the crash of the application after approximately 20 minutes of usage.

4.2. Experiment 2

Besides manually testing the application for its functionality, we have also taken a step forward to introduce the application to real-life situations and audiences. After careful contemplation of the program, we decided to organize a workshop that presents and utilizes The Drawing Plan. Tasks such as making a flier, rearranging the program's website, and promoting the lesson to the corresponding community are all parts of this workshop. This workshop takes the form of storytelling and art. A few topics are organized to be discussed and drawn during the lesson to guide the students to tell their stories. For instance, prompts like "Pairing up with a partner, have them tell you what they did today, and you can draw it out!", and "I will draw something now, and someone will make up a story of what I draw!" motivated the young children to actively engage with each other and in our activities. Eventually, we received participation from eleven children under the age of 10 along with their parents and guardians attending our lesson.

It is very intriguing to see our young students' works of art when they are told to draw as many of them evoke a clear sense of personality and style for art. Specifically, each individual's use of colors, composition, texture, shapes, and the content of their drawings vary. One student adopted abstract elements in their drawings, such as the depiction of colors in geometric shapes, the overlap of rough and bold brush strokes using the acrylic and crayon textures. Another student, prominently, favors round compositions by building a circular frame on his canvas each time he draws, and utilizes softer textures such as the watercolor and pencil brush. He illustrates looseness in his drawing by using blocks of colors but with dynamic lines and shapes. And some other students work more graphically with direct, simple, and straightforward lines portraying their subject of art, rendering realism with a wide range of colors.

Through these student works, we, as the developer and designer of this application, can see their individual characteristics: those who appear introverted and uncommunicative can be as artistic and expressive as those who are talkative and extroverted in their works of art. This experiment result leads to the ultimate purpose of this application: tell your story, feelings, and emotion with art.

Prominently, one conversation that I remember having with a young girl in the classroom, regarding the drawing prompt, "Draw a person and a hand!", clearly demonstrated that she is living a safe, healthy live. The intention of this prompt was to bring out possible experience of physical assaults or harassment. One who has had such experience, and is a child, has the chance to reveal what happened to them and may be deeply terrified when they encounter this prompt. Yet, this girl in class was bored and disappointed when this drawing prompt appeared on her screen because she saw no purpose for it. Her work consisted of a person standing, and a separate drawing of a hand. The nature of her reflects her life, and that her joyous, communicative personality is authentic.

5. RELATED WORK

In Allison Cuellar's "Preventing and Treating Child Mental Health Problems", she addresses the potential flaws in the United State's policies and programs for treating children's mental health, including the lack of funds and ineffectiveness of current treatment approaches [10]. Cuellar suggests that most treatments focus on relieving symptoms instead of curing the patients from their roots, which is the reason why success in combating mental illness sometimes doesn't last. The Drawing Plan has the intention to treat mental disorders among children by discovering what the child struggles with, with the use of drawing prompts; this embarks the journey of uncovering the cause and further exploring the needs of the child.

In "Therapy to Improve Children's Mental Health", published by The Centers of Disease Control and Prevention(CDC), suggests three types of effective therapies for children: parent training in behavior management, child behavior therapy, and cognitive-behavior therapy [11]. These types of therapy often include talking and playing, either individually with the patient or the patient's parents, or as a group. Communication and fun activities can undoubtedly ease a child's mind to help adults understand their situation, drawing can, too. The functionality of The Drawing Plan can add to the modules of these therapy, providing an alternative method to approach child therapy. Especially to treat autism, art and creativity is a substantial way of communication.

The National Institute of Mental Health states that when it comes to treating children's mental disorders, it is recommended to communicate with parents and close adults around the child about the child's usual behavior [12]. Yet, a parent or caregiver cannot be mindful and especially omniscient at all times. Rather, it is important to pull attention onto the child and have them

express their struggles through a method that suits them, some, it would be art. In conclusion, verbal communication and physical behavior, such as playing, drawing, facial expression, should be combined in therapy for a more accurate result on a child's psychological stage.

6. CONCLUSIONS

The Drawing Plan is an application where young children are motivated to create and draw their very own stories with the guidance of provided drawing prompts. Upon entering the Get-A-Prompt option of the application, the randomly chosen drawing prompts are designed for children under their first-stage treatment, which is for adults to get to know the child's struggles. Then, the Make-A-Prompt option is designed for adults to be directly involved in the care of a child's mind: they can create specific drawing prompts for the child. Through the experiments done for this application, we are sure that The Drawing Plan has a value and that it will serve a purpose of child psychology and therapy [13]. Witnessing a range of personalities and interests through drawings produced by young children proves the usefulness of this application.

One limitation of The Drawing Plan is that the current drawing prompts may only reveal superficial problems for some users. For instance, some of the current drawing prompts says, "What does you dream birthday party look like?", or, "You are home alone, what do you do?". These prompts may be effective for children with mental disorders such as autism or ADHD, in which the symptoms of these diseases include a lack of response or over response [14]. Yet, what if the child only suffers mild symptoms? Such as they have friends and accompany but emotionally feel insecure and lonely? A child like this may still draw the positive aspect of their life when they are asked to, yet adults and caregivers may not be able to detect the hidden emotions. The Drawing Plan needs to take further consideration to enhance the current prompts in order to ensure better accuracy in its results.

To solve this limitation, I will be examining more books and articles regarding children psychology and therapy to find out how to guide a child's communication more effectively. I will also be launching more experiments and community services related to this topic to gain practical understanding of children's behaviors [15].

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