AN INTELLIGENT AND AI-DRIVEN APPLICATION TO PROMOTE MENTAL WELLNESS AND SELF CARE USING NATURAL LANGUAGE PROCESSING AND GAMIFICATION

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ABSTRACT

Poor mental health and mental illness have become more widespread in recent years, resulting in a greater need to expand the accessibility of mental health treatment. To address this issue, this study proposes an application to provide a widely appealing and easily accessible alternative to traditional mental health treatment by implementing an artificial intelligence chatbot and gamification of self-care. The AI chatbot serves as a companion, counselor, and self-help advisor for individuals who are unable to seek professional human help, while gamification incentivizes users to maintain self-care habits which can improve both physical and mental well-being. The application uses Unity as the basis for its gameplay elements, and Inworld AI to simulate realistic and dynamic conversations through natural language processing. In an experiment involving the application, results demonstrated a greater reduction of anxiety and depression symptoms among application users than among non-users. These results highlight the positive impact of AI chatbots and gamification on overall mental health.

KEYWORDS

Artificial intelligence, Gamification, Anxiety, Depression

1. INTRODUCTION

Mental health is a crucial aspect of an individual's overall well-being, encompassing their emotional and psychological state, coping abilities, relationships, decision-making skills, learning capabilities, and emotional balance [1][2]. Unfortunately, mental illness affects a significant portion of the population, with 1 in 5 adults and 1 in 5 youth currently or previously experiencing it [2]. Poor mental health can lead to a lack of motivation, which can hinder one's ability to face daily challenges, maintain fulfilling relationships, and lead a productive life. This, in turn, can increase lifestyle risks and negatively impact overall well-being. Research has linked depression to various health problems, including insomnia, cardiovascular disease, inflammation, and eating disorders , with depression also increasing the risk of death by 24% [3][4][5]. Individuals experiencing mental health problems are also at higher risk of developing suicidal thoughts, with 4.8% of U.S. adults (~12.1 million) reporting

David C. Wyld et al. (Eds): BDAP, AIS, NLPA - 2023
pp. 41-55, 2023. CS & IT - CSCP 2023 DOI: 10.5121/csit.2023.131105

such thoughts, and a significant proportion of high school students considering or attempting suicide [6][7].

The COVID-19 pandemic of 2020 has further exacerbated the issue of poor mental health, with a 25% increase in global prevalence of depression and anxiety in the first year alone [8]. Mental Health America has reported a 200% increase in screenings for depression, anxiety, and loneliness from 2019 to 2020 [9]. In 2021, over 50 million U.S. adults (21%) reported experiencing mental health problems [10]. Despite this alarming increase, many individuals with mental health issues still do not receive proper treatment. A significant proportion of adults with mental illness (54.7% or ~28 million) do not receive any mental health treatment, while 28.2% (~15 million) receive inadequate treatment that fails to meet their needs. Various factors contribute to this, including the inability to afford treatment (42%), lack of knowledge about where to seek help (27%), beliefs that they can manage without treatment (26%), lack of time (19%), and lack of health insurance coverage (17%) [6]. Additionally, fear of stigma, negative opinions, and concerns about confidentiality can prevent individuals from seeking treatment, with 36% of people experiencing mental illness failing to report their condition [10]. Furthermore, there is a shortage of mental health workers in many areas of the U.S., with only 28% of treatment needs met for the 152 million people living in shortage areas, and a national ratio of one mental health provider for every 350 individuals [6].

Several studies exist examining various mental health intervention strategies and their effectiveness. O'Reilly, M. et al. reviewed universal school-based intervention and its effectiveness across ten experiments [17]. In each experiment, mental health help was provided to primary and secondary school students through mental health and resilience programs, yoga, health classes, etc. to varying levels of success. Though eight out of ten of the experiments exhibited positive impacts on mental health, universal school-based interventions are limited by lack of consistency, support from teachers, interest from students, and from over-generalization of the complexities of mental health. Thus, our study seeks to address these limitations with the application of AI chatbots and gamification to mental health help, which offers greater appeal, engagement, and customizability. Artificial intelligence has already been applied to the mental health field as mental health-detecting machine algorithms. This is presented in a paper written by Graham, S. et al., wherein twenty eight studies involving the use of artificial intelligence to predict and detect signs of poor mental health were examined. Results reported overall high accuracy among artificial intelligence programs, suggesting its potential in mental healthcare, but the efficacy of this usage is constrained by the size and quality of data, which can restrict the generalization of results if sample sizes are too small or homogenous. Alternatively, artificial intelligence can directly address mental health concerns through the implementation of a chatbot. In a trial conducted by Klos, M. et al., 181 Argentinian college students were divided into an experimental group, who interacted with an AI chatbot, and a control group, who were provided with a psychoeducational book on depression. Anxiety and depression symptoms were recorded at the beginning and end of the trial, with results revealing a greater decrease of anxiety and depression symptoms among experimental participants than control participants. However, the study's results may have been altered by a homogenous sample size, and a high dropout rate over the course of the trial. Our study expands on the potential positive impacts of AI chatbots on mental health demonstrated in Klos, M. et al.'s paper [19] by supplementing it with the gamification of self-care alongside relaxing gameplay. These additions aim to further improve mental health by encouraging self-care habits, which are integral to good mental health, and reducing stress.

Our innovative solution is an application that gamifies self-care and utilizes an AI chatbot to promote proper mental health maintenance. Gamification is the process of incorporating video game elements into non-game settings to increase user engagement through incentives [11]. In our application, gamification is used to encourage users to complete self-care tasks through the integration of quests and rewards. The virtual pet's "needs," which decrease over time, also provide motivation for continual interaction and commitment to self-care habits. This approach makes the application appealing to a broader audience, as gamification has become increasingly popular [12]. By building healthy self-care habits, users can improve their physical and mental well-being through regular physical activity, meditation, self-reflection, and stress management, leading to good mental health [13][14]. Furthermore, the inclusion of casual and relaxing games can help to reduce stress, leading to improved overall mental health [15].

Our application also includes an AI chatbot that allows users to engage in realistic conversations. As previously mentioned, many individuals with mental health issues do not seek help due to cost, stigma, or lack of accessibility [6][10]. The AI chatbot, represented as a virtual pet, serves as an alternative to traditional therapy and can offer support to those struggling with depression, loneliness, and other mental health issues. The chatbot can provide advice, suggest potential tools, and listen to users' concerns. This approach is less expensive than most forms of mental health treatment and offers privacy and confidentiality for users, making it accessible to those who may not have access to traditional forms of therapy.

Our experiment sought to analyze and observe the effects of AI chatbot and gamification intervention on mental health. This was done by recording the severity of anxiety and depression symptoms across six participants recruited from a highschool in California, United States. The participants were randomly separated into an experimental group and a control group. Experimental participants were granted limited access to an AI chatbot, and unlimited access to a virtual pet game which incorporated self-care management, while control participants were instructed to record their feelings in a journal and directed towards online self-care resources. At the beginning of the experiment and after two weeks, participants completed the GAD-7 and PHQ-9 to measure the severity of anxiety and depression symptoms. Results showed a greater decrease in anxiety and depression symptoms in the experimental group compared to the control group, likely due to interaction with the chatbot and engagement with the game. However, the decrease in depression symptoms was lower than expected, either due to reduced effectiveness of intervention methods on depression, or a small sample size.

2. CHALLENGES

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

2.1. System and model

When considering which system and model to use for our chatbot depends on a variety of factors, we will consider the ease of implementation, cost, and AI accuracy of each option. Lack of experience with natural language processing and AI development requires the system to be easily implemented. Lack of funding restricts our options to free models, which often come with limited usage quotas. Finally, due to the diversity of mental health concerns, customizability and accuracy are essential for providing the best user experience. Dialogflow provides a code-free system which uses machine learning to improve conversations, though takes time to implement. Rasa grants greater customizability for individual users, but requires greater technical knowledge and costs money.

Alternatively, OpenAI API trains from a vast database and requires only training prompts to learn, but is subject to database bias, and costs money. Botpress is simple to use, does not require coding experience, and is free, but lacks proper Unity implementation. We could use In World AI, which offers quick and easy implementation and high customization, but has a daily usage quota across all users and requires payment for additional hours of use.

2.2. Platform issue

The goal of the application is to make mental health help accessible to those who cannot receive traditional treatment or therapy. Thus, it is important to make the application available on a variety of platforms, including laptops, desktops, iOS, and Android. In order for the application to be used across computers and mobile devices, we could use portrait form, as it is the most common orientation for mobile apps, and allows the application to serve as a background or side window on computers. Additionally, the application's layout and features must be easily identifiable and used to maximize user experience and reduce potential confusion. This could be accomplished with a minimalist design to increase readability, and a tutorial which instructs users on the various features of the application.

2.3. Store elements

Several game elements need to be stored between sessions to maintain continuous progression. These include the needs of the pet, journal entries, currency, and completed and uncompleted tasks. One option is to use JSON files to store the required elements. Although JSON files require more code and setup to implement, they are readable by humans and data can be easily extracted, and allow for data categorization in different files for different game elements. Because JSON files are stored externally, they can be edited outside of Unity and imported into other platforms, allowing us to expand the accessibility of the application. JSON files can also handle a variety of data types and store complex data structures. We can also use Unity's built-in PlayerPrefs class, which is easy to implement, but can only handle simple data structures, only accepts integer, float, and string values, and is stored locally and can only be accessed through the Unity editor or the user's individual application.

3. SOLUTION

Our application is divided into three primary components: a game system, a self-care management system, and a chatbot service. Unity and its various libraries were used to create the game and self-care management features, while the Inworld AI Unity SDK was used to implement the chatbot. Inworld AI was chosen due to its ease of implementation and customizability.

When the application is first launched, users are presented with a disclaimer on the limited usage of the AI chatbot, and a tutorial that can be accessed in the settings. Once on the main UI, users are able to pan the camera by clicking on the left or right side of the screen. The main UI consists of several individual buttons which access different elements of each of the application's components. On the top right, the heart button displays the virtual pet's current stats. Below that, the food button opens the food menu, where users can use in-game currency to buy various food items for the pet. The controller button accesses the activities menu. Here, users can either interact with the pet through several pet care activities, or complete personal self-care tasks. The last of the right side buttons is the cosmetics button, which opens the cosmetics shop and allows users to purchase cosmetics for the pet with in-game currency. On the left, the settings button allows users to adjust volume, view the tutorial, or reset data. Underneath is the journal button, where users can write in one of two journals - the rant or gratuity journals - and save their entries between sessions. The last button is the chat button, which accesses the AI chatbot menu, where users can send and receive messages to and from the Inworld AI, provided they have internet access.

Figure 1. Overview of the solution

A core part of our application is the game system. The various game elements, specifically the pet's needs, which decrease over time, are integral towards incentivizing continued user engagement, which is especially important for the self-care management system to encourage proper self-care habits. The game elements are also intended to provide relaxing and calming entertainment to reduce stress, thus improving mental health. The game system is built using Unity, C# programming, and several assets from the Unity Asset Store.

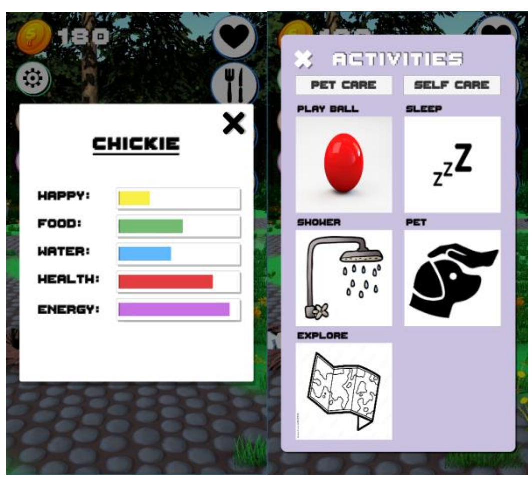

Figure 2. Screenshot of the app

```
void Start()
{
    StartDropRates();
    if (PlayerPrefs.HasKey("First")) LoadNeeds();
    UpdateNeeds();
}

1 reference
void UpdateNeeds()
{
    if (PlayerPrefs.HasKey("Last Open"))
    {
        double timeLapsed = (System.DateTime.UtcNow -
            DateTime.Parse(PlayerPrefs.GetString("Last Open"))).TotalSeconds;
        ChangeHappiness((float)-timeLapsed / happinessAFKRate * happinessDropRate);
        ChangeFood((float)-timeLapsed / foodAFKRate * foodDropRate);
        ChangeWater((float)-timeLapsed / waterAFKRate * waterDropRate);
        ChangeHealth((float)-timeLapsed / healthAFKRate * healthDropRate);
        ChangeEnergy((float)-timeLapsed / energyAFKRate * energyDropRate);
        ChangeAffection((float)-timeLapsed / affectionAFKRate * affectionDropRate);
    }
}

1 reference
void StartDropRates()
{
    StartCoroutine(PerformHappinessRateDrop());
    StartCoroutine(PerformFoodRateDrop());
    StartCoroutine(PerformWaterRateDrop());
    StartCoroutine(PerformHealthRateDrop());
    StartCoroutine(PerformEnergyRateDrop());
    StartCoroutine(PerformAffectionRateDrop());
}
2 references
IEnumerator PerformHappinessRateDrop()
{
    yield return new WaitForSeconds(happinessTimeRate);
    currentNeeds.happiness -= happinessDropRate;
    StartCoroutine(PerformHappinessRateDrop());
}
2 references
IEnumerator PerformFoodRateDrop()...
2 references
IEnumerator PerformWaterRateDrop()...
2 references
IEnumerator PerformHealthRateDrop()...
2 references
IEnumerator PerformEnergyRateDrop()...
2 references
IEnumerator PerformAffectionRateDrop()...

public void LoadNeeds()
{
    if(PlayerPrefs.HasKey("Happiness"))
    {
        currentNeeds.happiness = PlayerPrefs.GetFloat("Happiness");
        currentNeeds.food = PlayerPrefs.GetFloat("Food");
        currentNeeds.water = PlayerPrefs.GetFloat("Water");
        currentNeeds.health = PlayerPrefs.GetFloat("Health");
        currentNeeds.energy = PlayerPrefs.GetFloat("Energy");
        currentNeeds.affection = PlayerPrefs.GetFloat("Affection");
    }
}
1 reference
public void SaveNeeds()
{
    PlayerPrefs.SetFloat("Happiness", currentNeeds.happiness);
    PlayerPrefs.SetFloat("Food", currentNeeds.food);
    PlayerPrefs.SetFloat("Water", currentNeeds.water);
    PlayerPrefs.SetFloat("Health", currentNeeds.health);
    PlayerPrefs.SetFloat("Energy", currentNeeds.energy);
    PlayerPrefs.SetFloat("Affection", currentNeeds.affection);
}
```

Figure 3. Screenshot of code 1

The game system's main attraction is the virtual pet's needs stats, including Happiness, Food, Water, Health, and Energy. These stats decrease over time to encourage user engagement. The system achieves this through two methods: Start Drop Rates and Update Needs. Start Drop Rates initializes several coroutines when the application launches to reduce each need by a set amount after a specific time interval. These coroutines repeat throughout the user's interaction with the game, consistently decreasing the needs over time.

If the user has previously used the application, the Load Needs method loads the virtual pet's previous needs, which are saved in PlayerPrefs through the Save Needs method when the application is closed. The Update Needs method is then called to reduce the virtual pet's needs based on the time elapsed since the user's last interaction. The method first checks if the "Last Open" PlayerPrefs key exists, which records the time when the application was last closed. If it does, the time elapsed since then is calculated in seconds and used to decrease each need based on a specified rate.

The second component of our application is the self-care management system, which includes a self-care task system and a journal. The goal of the self-care system is to allow users to practice healthy self-care habits by rewarding them with in-game currency in exchange for the completion of specific tasks. The journals allow for self-reflection and self-expression, which are important aspects of self-care.

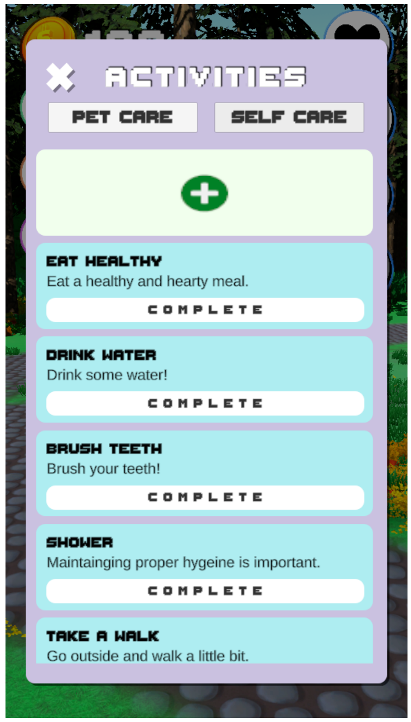

Figure 4. Screenshot of activities

```
public struct SelfCareTask
{
    public string name;
    public string description;
}
```

```
void Start()
{
    DateTime lastLoginTime = PlayerPrefs.HasKey("Last Login Date") ?
        DateTime.Parse(PlayerPrefs.GetString("Last Login Date")) : DateTime.MaxValue;
    if (DateTime.Now.Date > lastLoginTime)
    {
        RefreshTask();
        PlayerPrefs.SetString("Last Login Date", DateTime.Now.Date.ToString("yyyy-MM-dd"));
    }
    TaskLoad();
    SpawnTask();
}
```

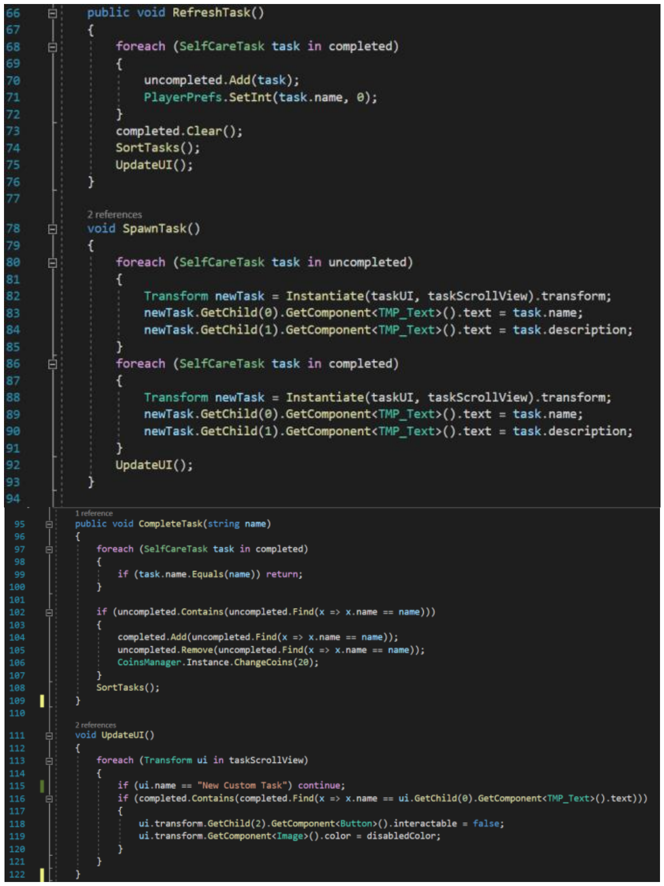

Figure 5. Screenshot of code 2

In the application, users are incentivized to complete various self-care activities through the self-care task system. This is accessed through the self-care activities menu. Self-care tasks are represented in a SelfCareTask struct, which contains a task's name and description, and are stored in a SelfCareTasks List called allTasks. During runtime, self-care tasks are sorted into a completed or uncompleted list and displayed accordingly on the UI.

When the application is launched, the current date is compared to the player's lastLoginDate, stored as a String using PlayerPrefs. If a day has passed since lastLoginDate, all tasks are refreshed to be uncompleted through RefreshTasks, and a new lastLoginDate is set. Then, TaskLoad adds every task found in allTasks - a predefined list of self-care tasks - to the completed or uncompleted lists based on their PlayerPrefs key. Once the lists are sorted, SpawnTask instantiates a taskUI object in the self-care activities menu, with the uncompleted tasks at the top and completed tasks on the bottom, and UpdateUI disabling completed tasks from being clicked. Whenever users complete a self-care task, CompleteTask adds that task to completed, removes it from uncompleted, gives the user twenty in-game coins using CoinManager, and then sorts the self-care task menu using SortTasks, which destroys every taskUI in the menu and calls SpawnTask.

The application's third and final component is the AI chatbot service. The AI chatbot is able to simulate human-like conversations with users, which can provide an outlet for the user's feelings, emotions, concerns, and worries, and provide advice on how to handle such issues. This is done through the implementation of the Inworld AI Unity SDK, which communicates with the Inworld server and uses a NLP service. Natural language processing (NLP) is a machine learning process which allows computers to understand human language.

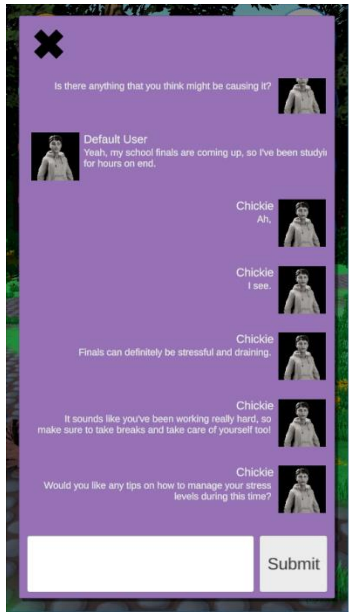

Figure 6. Screenshot of chatbot

```
/// <summary>
///     UI Functions. Called by button "Send" clicked or Keycode.Return clicked.
/// </summary>
public void SendText()
{
    if (string.IsNullOrEmpty(m_InputField.text))
        return;
    InworldController.Instance.CurrentCharacter.SendText(m_InputField.text);
    m_InputField.text = null;
}
/// <summary>
///     Send Text to this Character via InworldPacket.
/// </summary>
/// <param name="text">string of the Text.</param>
public void SendText(string text)
{
    SendEventToAgent
    (
        new TextEvent
        {
            Text = text,
            SourceType = Grpc.TextEvent.Types.SourceType.TypedIn,
            Final = true
        }
    );
/// <summary>
///     Set general events to this Character.
/// </summary>
/// <param name="packet">The InworldPacket to send.</param>
public void SendEventToAgent(InworldPacket packet)
{
    if (!Data || string.IsNullOrEmpty(ID))
        return;
    packet.Routing = Routing.FromPlayerToAgent(ID);
    if (packet is TextEvent text)
    {
        // Adding text to history if interactions.
        if (m_Interaction)
            m_Interaction.AddText(text);
    }
    InworldController.Instance.SendEvent(packet);
}
```

```
/// <summary>
///     Send an InworldPacket to Inworld Server
/// </summary>
/// <param name="packet">InworldPacket</param>
4 references
public void SendEvent(InworldPacket packet)
{
    m_Client.SendEvent(packet);
}
internal void SendEvent(InworldPacket e)
{
    if (IsInteracting)
        m_CurrentConnection?.outgoingEventsQueue.Enqueue(e.ToGrpc());
}
internal async Task StartSession()
{
    if (!IsSessionInitialized)[...]
    // New queue for new session.
    Connection connection = new Connection();
    m_CurrentConnection = connection;

    IsInteracting = true;
    try
    {
        using (m_StreamingCall = m_WorldEngineClient.Session(m_Header))
        {
            // https://grpc.github.io/grpc/csharp/api/Grpc.Core.IAsyncStreamReader-1.html
            Task inputTask = Task.Run
            (
                async () =>
                {
                    while (IsInteracting)
                    {
                        bool next;
                        try
                        {
                            // Waiting response for some time before checking if done.
                            next = await m_StreamingCall.ResponseStream.MoveNext();
                        }
                        catch (RpcException rpcException)
                        {
                            if (rpcException.StatusCode == StatusCode.Cancelled)
                            {
                                next = false;
                            }
                            else
                            {
                                // rethrowing other errors.
                                throw;
                            }
                        }
                        if (next)
                        {
                            GrpcPacket response = m_StreamingCall.ResponseStream.Current;
                            if (response.DataChunk != null)[...]
                            else if (response.Text != null)
                            {
                                connection.incomingInteractionsQueue.Enqueue(new TextEvent(response));
                            }
                            else if (response.Gesture != null)[...]
                            else if (response.Control != null)[...]
                            else if (response.Emotion != null)[...]
                            else if (response.Custom != null)[...]
                            else[...]
                        }
                        else
                        {
                            InworldAI.Log("Session is closed.");
                            break;
                        }
                    }
```

Figure 7. Screenshot of code 3

It is important to know that this code was not created by anyone on the research team, but rather, by the Inworld team, who publicly shared it through the Unity Asset Store.

In order to simulate realistic conversations through a chatbot, the application sends and receives messages from the Inworld server, which processes user inputs and returns appropriate responses using natural language processing. Communication begins in the InworldPlayer class with the SendText method, which is called whenever the Send button is clicked. When called, if user input exists in the input field, the input field is emptied and the user input is sent to the Inworld Character, or the AI chatbot, in the form of an InworldPacket through the SendEventToAgent method in the InworldCharacter class. This packet is then sent to the Inworld server and queued in the outgoing events queue using the Send Event methods found in InworldController and InworldCharacter. Once the packet reaches the server, NLP is used to process the message, and a response is returned. The response is received in StartSession of InworldClient. In this asynchronous Task, the chatbot session is initialized, provided an internet connection is available, and users are able to interact with the chatbot. During interaction, the code checks the current response found in the response stream; if the text variable of the response is not empty, it is queued into the incoming interactions queue.

4. EXPERIMENT

In order to evaluate our application's effectiveness at improving mental health through intervention and promotion of self-care habits, an experiment must be conducted to measure symptoms of anxiety and depression among participants.

Participants were high school students in California, United States and were recruited through flyers placed throughout the high school. A total of six participants were recruited and consented to taking part in the experiment. A computer algorithm randomly assigned participants to an experimental or control group, with an even split of three participants in each group.

Those in the experimental group were given access to the application and were permitted a maximum of twenty minutes of daily interaction time with the AI chatbot each. This is due to the daily usage quota imposed on the chatbot by Inworld AI's free version. The experimental participants had unlimited access to the game and self-care elements of the application.

Those in the control group were instructed to write their thoughts and feelings in a private journal and follow self-care tips as often as possible.

The experiment was conducted over two weeks, and anxiety and depression symptoms were recorded at the beginning and end of the experiment. This was done using the Generalized Anxiety Disorder-7 (GAD-7) and Patient Health Questionnaire-9 (PHQ-9), self-reporting questionnaires which screen the presence and severity of generalized anxiety disorder and depression respectively on a numerical scale.

Variable	Group	Initial Average Score	Week 2 Average Score
Anxiety (GAD-7)	Experimental	10	8.33
	Control	10.33	10
Depression (PHQ-9)	Experimental	10.33	9.67
	Control	8.33	8

Figure 8. Figure of experiment 1

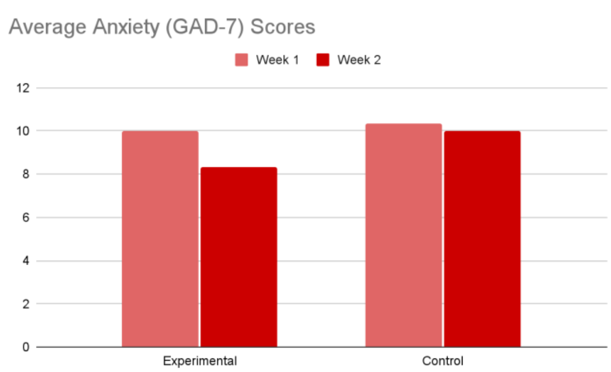

Figure 9. Average Anxiety (GAD-7) Scores

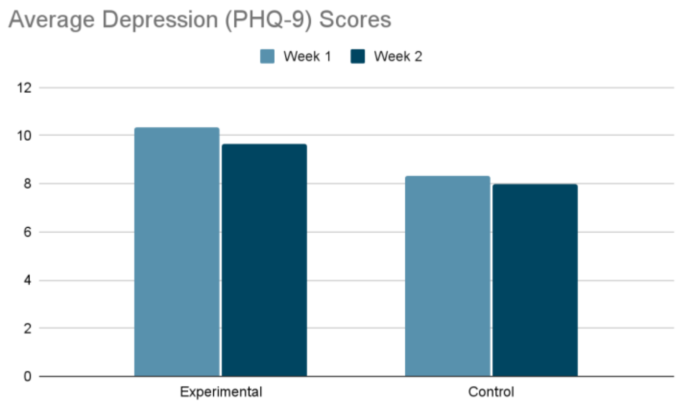

Figure 10. Average Depression (PHQ-9) Scores

The graphs depict the average anxiety (GAD-7) and depression (PHQ-9) scores of the experimental and control groups at week 1 and week 2.

At week 1, the experimental and control groups reported similar mean scores for anxiety symptoms, and in regards to depression symptoms, the experimental mean score was greater than the control mean score. By week 2, the experimental mean score for anxiety symptoms was lower than that for the control, whereas the experimental mean score for depression symptoms remained greater than the control's.

Each mean score decreased, but the decrease in anxiety and depression symptoms in the experimental group was observed to be greater than the decrease in the control group. For anxiety symptoms, the experimental group decreased by ~2.66, and the control group by ~0.33. For depression symptoms, the experimental group decreased by ~0.67, and the control group by ~0.33.

What this suggests is that artificial intelligence chatbots and gamification can improve overall mental health, as participants who interacted with these elements experienced a greater decrease in mental illness symptoms than those who did not. However, the effect on depression symptoms was minimal and much lower than initially anticipated. This could be because chatbot and gamification intervention are less effective at addressing depression than anxiety, or the small sample size altered results.

5. RELATED WORK

O'Reilly, M. et al. reviewed several studies to examine the effectiveness of mental health intervention strategies implemented in a school setting [17]. Ten studies were included, and focused on universal intervention, a generalized approach which targets an entire population or group, in this case, students in primary and secondary school. A majority used whole-school approaches, where intervention was applied throughout one or several schools. Strategies observed include mental health promotion programs, resilience programs, yoga, health classes, and DVD intervention. Eight of the studies reported a positive impact on mental health from intervention, demonstrating the overall effectiveness of each strategy. However, school-based universal intervention is still limited, as they often lack consistent implementation. This can be due to limited resources in certain schools, or lack of teacher commitment, who were often tasked with administering intervention and may have had other priorities. Additionally, students are sometimes uninterested in mental health intervention. Universal intervention and a generalized approach ignores the complexity and diversity of mental health, further reducing the impact for more nuanced cases. Our solution seeks to remedy this by providing a customizable mental health help experience through an artificial intelligence chatbot. The chatbot and gamification also appeal to students because of the popularity of games, and provide a semi-consistent intervention, so long as the user continues to interact with the application.

Graham, S. et al. studied the application of artificial intelligence in mental health care through the analysis of twenty eight studies which involved the use of AI in a mental health setting [18]. In the studies selected, AI was implemented in a variety of systems such as electronic health records and social media platforms to detect, predict, monitor, and classify signs of mental illness and poor mental health. A majority of studies used supervised machine learning (SML), with natural language processing (NLP) used second most. Deep learning (DL), computer vision (CompV), and unified modeling language (UML) were also included in several included studies. The results of the study showed that artificial intelligence was generally accurate in its application, ranging from 62% to 98%. The efficacy of AI in this context is reliant upon the size and quality of data, as small and homogenous sample sizes can hinder generalized applicability of findings. This study and the studies included within it focused on using AI to predict and identify mental illness, but does not provide a plan of intervention. On the other hand, our study adopts a more direct approach to mental health care by using AI to improve mental health and alleviate mental illness symptoms.

Klos, M. C. et al. analyzed the impacts of artificial intelligence chatbots on depression and anxiety using a controlled trial [19]. In the trial, 181 Argentinian college students were assigned to an experimental or control group. Over the course of eight weeks, students in the experimental group interacted with Tess, an AI chatbot, while students in the control group were instructed to read a psychoeducation book on depression. Anxiety symptoms and depression symptoms were recorded at the beginning and end of the trial. Results indicated a significant decrease of anxiety and minor decrease of depression within the experimental group, neither of which the control group experienced. The trial contains several limitations, including that all participants came from Entre Ríos, Argentina, resulting in a less diverse sample size, and a significant abandonment or dropout rate during the trial, which reduced sample size. Our experiment expanded on the ideas presented by this trial, as we considered the impacts of both AI chatbots and self-care gamification, which is not addressed in this paper. Gamification serves to enhance the positive impact on mental wellbeing by promoting self-care habits and reducing stress through relaxing activities.

6. CONCLUSIONS

In this study, the participant sample size was small, and was restricted to students from a specific high school in California. Additionally, the experiment occurred over a relatively short time frame. Thus, the generalizability of our findings is limited; to address this, the future studies should include a larger and more diverse participant sample and a longer experiment period.

The limited participant number is largely due to the AI chatbot's limited usage. The current chatbot is based on Inworld AI's free plan, which permits a maximum of sixty minutes of daily interaction shared across all users, along with a bonus of two hundred minutes of interaction. This restricted the number of participants and their allotted usage of the chatbot during the experiment. In order to address this limitation, alternative chatbot services which offer increased interaction time must be explored. One option is to acquire funding to upgrade to a higher plan or a different AI service, such as Rasa, Dialogflow, or OpenAI. Alternatively, we could build our own natural language processing and AI chatbot system, although this method requires significant technical knowledge and server costs to host the AI.

The experimental group interacted with both the gamification and chatbot elements of the application, which makes it difficult to precisely determine the individual effects of each variable on mental health. Thus, it is recommended that future studies include an additional group that has access to only one of the two variables.

This is reflected in participant feedback which reported the application's game elements to be lackluster and uninteresting in the long term, largely due to lack of game design experience. This likely impacted motivation to continue interaction with the game and self-care systems of the application, and reduced the impact of gamification. Additional updates to make game features more engaging, interesting, and fun is necessary to ensure gamification encourages user engagement.

Among the control group, there was no reliable method to ensure each participant used the assigned resources and perform recommended activities, and so, the precise impact of our instructions cannot be measured.

The study coincided with the approach of Advanced Placement and final exams in a few weeks for many of the participants, which may have worsened their mental health and reduced the impact of intervention, thus altering results. To avoid this, future studies should be conducted under conditions without extreme stressors.

The application of artificial intelligence chatbots and gamification could effectively address the increased prevalence of poor mental health and mental illness, and the widespread inability to access proper treatment, by making mental health help more accessible and appealing. Our application and study demonstrates the potential positive impacts of both, but several limitations require that our findings be considered carefully. Continued experimentation and research is necessary to acquire additional evidence towards a proper conclusion.

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