

AI-Based Student Stress Management System



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Abstract

Stress, anxiety, and depression are some of the mental health issues that are increasingly becoming common among university students and usually, they go unaddressed either because of social barriers or lack of support. The AI-Based Student Stress Management System provides a confidential, interactive system, which measures and analyzes the mental health of students through validated questionnaires (PSS, GAD-7, PHQ-9) and machine learning algorithms. It categorizes the level of stress in real-time and offers customized assistance with the help of an AI-enabled chatbot educated in DSM-5 and other materials. The system also comprises games designed to relieve stress, breathing activities and mindfulness to aid in the emotional well-being so that the students can check their mental state after using these applications. Moreover, the system has the advantage of offering students the chance of making appointments with professional doctors and counselors at the Bahria University Well-being Center to receive higher-level assistance. The Well-being Department has a specific administration panel, which allows the administrators and health professionals to track student activities, assessments, and progress to ensure that the intervention is provided in a timely manner. Future enhancements involve incorporation of facial expression detection in order to better detect stress. The project is focused on empowering students by providing mental health-related support with accessible and judgment-free AI services, as well as enhancing the bond between the students and the professional well-being resources.

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*“We think someone else, someone smarter than us,
someone more capable, someone with more resources will solve that problem.
But there isn’t anyone else.”*

Regina Dugan

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Acronyms and Abbreviations

AI	Artificial Intelligence
API	Application Programming Interface
CSS	Cascading Style Sheets
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
GAD-7	Generalized Anxiety Disorder 7-item scale
HTML	Hyper Text Markup Language
JS	JavaScript
ML	Machine Learning
PHQ-9	Patient Health Questionnaire-9
PSS	Perceived Stress Scale
React	JavaScript library for building user interfaces
UI	User Interface
UX	User Experience

Chapter 1

Introduction

Academic pressures, financial disadvantages, and personal problems are mounting up stress, anxiety, and depression among university students around the world.[1]. In Pakistan, many suffer in silence because of poor mental health awareness and social stigma. During our internship at the National Center of Physics (NCP), Center of Excellence in AI, we explored the use of Artificial Intelligence (AI) in healthcare and realized that most existing platforms were generic, costly, and not suited to local needs. This led to the development of the AI-Based Student Stress Management System, an AI-driven platform built on verified surveys and machine learning algorithms to detect stress, anxiety, and depression, and provide AI chatbot support and stress-relieving games. Many students cannot access support on time due to financial concerns or lack of resources [2], which may result in poor academic performance and social issues. Current digital solutions are mostly subscription-based and focus only on self-evaluation or chatbots, lacking interactive stress-relief activities [3]. To fill this gap, we offer a holistic solution including mental health assessment using PSS-10, GAD-7, and PHQ-9 [4, 5, 6], stress-relief games, breathing exercises [7, 8], and individualized recommendations. The AI chatbot is trained on DSM-5 and psychological resources to provide coping strategies, relaxation tips, and referrals to university psychologists when needed [9, 10, 11]. Students can also book appointments at the Bahria University Well-being Center and receive detailed reports to monitor their progress. Designed with HTML, CSS, and JavaScript, the platform ensures a smooth, intuitive, and engaging user experience. While not a replacement for professional treatment, this project serves as an early intervention tool that helps students manage stress and seek professional help when necessary.

1.1 Project Background

Academic pressures, financial disadvantages, and personal problems are creating increasing stress, anxiety and depression in university students across the globe [1]. A lack of knowledge of mental health and the social stigma in Pakistan usually mean that students are not able to find their way to help in time, and many of them find themselves in a situation where they have no voice. As digital technologies emerge, Artificial Intelligence (AI) can provide new opportunities to provide personal, scalable, and affordable mental health solutions [12]. The concept of the project was formulated throughout our internship experience at the National Center of Physics (NCP), Center of Excellence in AI, during which we learned

about the possibilities of AI in healthcare and mental health and assessed the available platforms, the majority of which were generic, expensive, or did not accommodate local needs. After being inspired to tackle the student mental health issues in our academic community, we created the AI-Based Student Stress Management system an AI-driven student-centric platform. This system is founded on verified surveys and machine learning algorithms to establish the extent of stress, anxiety, and depression and offer it assistance as AI chatbot and stress-relieving games. Assessment, intervention, and self-monitoring will be incorporated in a personalized and interactive way to improve better mental health practices in students through the help of the project.

1.2 Problem Description

There is an increasing trend of stress, anxiety and depression among university students, and many are still unable to access the support in time because they feel afraid of financial costs, or because of mental health resources [2]. Consequently, such problems usually remain unnoticed and may result in low school achievement, anti-social behavior, and school dropout. Although there are digital mental health applications, the majority of them are subscription-based, general, and did not target Pakistani students. Moreover, they primarily provide self-evaluation or chatbot services, yet there are no interactive stress-reducing activities or games that could assist students to address the stress more efficiently [3]. This somehow requires an accessible, AI-driven platform that provides a combination of mental health testing, personalized support, and interactive stress relief to help the student with the stress with access to judgment-free and no-cost help [13]. This proposal will fill this gap by a system that targets university students. over project is not the same as the rest of the projects as we are offering a holistic solution to the issues of stress management in students. It contains stress evaluation, stress-relief games, and breathing exercises[7, 8], and has a chatbot that lets the students express themselves. The system also provides individualized recommendations depending on the level of stress of a student. The recommendations are referred to the Wellbeing Center of the university where students receive the assistance of professionals in case of necessity. The project brings the stress checking, support, and follow-up help together; this way, our project provides students with a more comprehensive consideration of their mental health.

1.3 Project Objectives

This project aims to design and develop an AI-based solution, which can assist university students to cope with stress, anxiety, and depression. The platform is supposed to offer proper mental health testing, personalized assistance, and interactive stress relief experiences in a confidential and non-restrictive manner. Through AI technologies and interactive

opportunities, the system will hope to jumpstart improved mental health behaviors among students and minimize the obstacles related to the help-seeking process.

The Most Important Goals of the Project Will Be To:

- Build a system that uses AI to determine the mental health condition of students by forecasting levels of stress, anxiety, and depression.
- Conduct mental health assessment using validated psychological scales(PSS-10, GAD-7, and PHQ-9)[4, 5, 6].
- Introduce efficient machine learning tools to categorize the severity (Low, Moderate, and High) of mental health issues in real time.
- Develop an AI chatbot trained on DSM-5 and psychological resources to provide individualized support, relaxation methods, stress coping strategies, and referrals to the most appropriate psychological doctors within the university when necessary [9, 10, 11].
- Add interactive stress-relief games to encourage students to actively cope with stress and improve their mood [14, 15].
- Offer a non-judgmental, private space where students can self-examine and manage their mental health without fear of social barriers.
- Promote positive mental health behavior by integrating assessment, intervention, and self-monitoring in an engaging way.
- Allow students to book appointments with professional doctors and counselors at Bahria University through the system for additional support when needed.
- Produce detailed reports on student assessments and progress so that both students and the Well-being Department can monitor improvements and identify areas needing attention.

1.4 Project Scope

1.4.1 Goals

- Determine the stress levels, anxiety levels, and the level of depression among university students.
- Deliver real-time mental health assistance.
- Provide stress relief games that are interactive to reduce anxiety and depression

- Provide AI chatbot support in relaxation exercises and coping skills.
- Provide a secure platform to guarantee user privacy and data security.
- Design an advanced, easy to use web solution.
- Give individual advice depending on the stress level of a student.
- Recommend to the Well-being Center of the university to get additional professional help.
- Allow students to reach out to doctors at the Well-being Center depending on the state of stress.
- Get students to access their assessment and appointment reports.
- Admin dashboard will allow the monitoring and review of student activities.

1.4.2 Features

1. Mental Health Assessment

Uses PSS, GAD-7, and PHQ-9 scales to evaluate stress, anxiety, and depression [4, 5, 6].

2. Machine Learning Prediction

Classifies mental health status as Low, Moderate, or High.

3. AI Chatbot Support

Provides coping strategies, relaxation tips, and recommends university psychologists.

4. Stress-Relief Games

Interactive games designed to reduce stress and improve mood

5. Real-Time Feedback

Allows students to reassess their mental health after using the platform tools.

6. Data Privacy

Keeps all user information confidential with no personal data collected.

7. DSM-5 and Psychological Resources

(Diagnostic and Statistical Manual of Mental Disorders) is used to identify common symptoms of stress, helping ensure that stress assessments are aligned with psychological standards[9, 10, 11].

8. Doctor Appointment Recommendation

Enables students to book appointments with professional doctors and counselors at the Bahria University Well-being Center for advanced support.

9. Report Generation

Gives comprehensive reports of the assessment, activities, and appointments of students to assist students and the Well-being Department in following the progress and developing interventions.

1.4.3 User-Friendly Web Design

- **Built with HTML, CSS, and JavaScript**

To deliver a smooth, responsive, and modern user experience.

- **Simple and Intuitive Layout**

Provides easy navigation for students with clear options and actions.

- **Interactive and Engaging Interface**

Designed to make stress management tools enjoyable and easy to use.

This project does not aim to replace professional psychological treatment but serves as an early intervention tool to help students manage stress, seek further help when necessary, and guide them by recommending a psychologist when professional support is required.

Chapter 2

Literature Review

Stress, anxiety, and depression in university students have become a major issue, which has made the problem of mental health support a pressing concern requiring viable and available solutions [1]. New technologies in digital form, such as chatbots powered by AI, standardized mental health assessment scales, and even informal video games, hold a lot of potential in the management and prevention of these common mental health conditions [12, 13]. Studies have shown that chatbots can provide important emotional support and establish an early intervention [2, 3], and that playing specific games and relaxation methods can be effective in reducing anxiety and enhancing emotions in general [14, 15, 7]. The instruments are generalized anxiety disorder 7-item (GAD-7), patient health questionnaire-9 (PHQ-9) and perceived stress scale (PSS). They are all validated tools that can solely be employed to adequately address the severity and course of these conditions [4, 5, 6]. The reviewed literatures draw on the key studies that indicate the topicality of these digital interventions and assessment methods in helping students with their mental well-being.

2.1 Understanding and Assessing Mental Health in Students

The first step in responding successfully to the mental health issues, affecting the university students is to correctly assess and measure the amount of stress, anxiety, and depression that they are feeling. This assessment is well covered using standardized psychological scales which offer clear classifications that are used in research and practice.

2.1.1 Perceived Stress Scale (PSS)

Perceived Stress Scale (PSS) is a highly used psychological tool that is aimed at quantifying how a person perceives the world to be stressed. In contrast to the diagnostic instruments used in the specific stress disorders, PSS is based on the perception of the unpredictability, uncontrollability, and the overload of the lives by individuals. [6].

- **Score Interpretation:**

- score of 0 to 13 usually indicates the absence of stress thus meaning that people generally believe that their lives are capable.

- The range between 14 and 26 indicates moderate stress which means that there is a perceived level of stress in everyday life.
- score between 27 and 40 represents a high stress level, which indicates the presence of high perceived stress levels that would need a deeper investigation or intervention.
- **Relevance:** The PSS is also a popular measure used in other literature reviews that talk about student stress especially in relation to academic pressure, social adaptation or health outcomes. It is essential to know all the classifications of its scoring to contextualize and interpret the results of research that presents stress levels among student groups.

2.1.2 Generalized Anxiety Disorder (GAD-7)

Generalized Anxiety Disorder 7-item (GAD-7) scale is a brief self-report questionnaire that is applied in screening and determining the severity of generalized anxiety disorder (GAD). It has seven questions that are directly related to the DSM-IV diagnostic criteria of the GAD making it a useful tool in tracking treatment response[4].

- **Score Interpretation:**
 - 0- 4 score will mean that the anxiety level is low and this implies that the symptoms of anxiety are minimal or nonexistent.
 - Scores between 5 and 9 indicate mild anxiety, where there are mild symptoms but which may not disrupt day to day functioning.
 - A severity of 10 to 14 corresponds to moderate anxiety and implies that there are more severe signs that might be affecting well-being.
 - Scores between 15 and 21 indicate high levels of anxiety which imply high and probably crippling symptoms that would need clinical intervention.
- **Relevance:** The GAD-7 is relevant in research exploring the prevalence of anxiety among students, the effectiveness of anxiety reducing interventions, or the correlation between anxiety and other academic or personal factors. Its scoring helps in understanding the importance of reported anxiety levels.

2.1.3 Patient Health Questionnaire-9 (PHQ-9)

Patient Health Questionnaire-9 (PHQ-9) is a self-reporting tool of screening, diagnosing, and monitoring the severity of depression that is widely validated and used. It is founded on the DSM-IV criteria of the major depressive disorder[5].

- **Score Interpretation:**

- The score of 0 falls under no depression and is a symptom-free measure of depression.
- A score of 1-4 implies little to no depression, and there are not so many symptoms to be diagnosed with it.
- A score of 5-9 is mild depression and this points to a few symptoms of depression, which could be involved in watchful waiting or short-term intervention.
- The scores of 10 to 14 are considered to be moderate depression implying that clinical symptoms are significant and can be improved by intervention.
- The scores of 15-19 indicate moderately severe depression, which means that the symptoms are significant and probably demand a therapeutic intervention.
- The range of 20 to 27 indicates a severe depression and indicates the extent of the manifestations of the case requiring a direct clinical response and treatment.

- **Relevance:** PHQ-9 plays a central role in the research of depression prevalence and effectiveness of depression treatment methods, as well as the overall effect of depressive symptoms on university students. Knowledge about its score classifications is important to be detailed to be able to interpret and apply it in research.

2.2 Literature Review Summary

Table 2.1: Literature Review

Author(s)	Title	Year	Source	Findings
Deshmukh K, et al.	Leora: A Chatbot for Stress Management using Artificial Intelligence[12]	2023	International Journal of Advanced Computer Science	Developed an AI chatbot (Leora) for stress management using sentiment analysis and therapeutic dialogues, showing user satisfaction in reducing stress.
Klos, M. C. et al.	Artificial Intelligence–Based Chatbot for Anxiety and Depression in University Students: Pilot Randomized Controlled Trial[13]	2021	JMIR Formative Research	The AI chatbot Tess was found to be acceptable and usable among Argentinian university students. While no significant differences were found between the chatbot and control groups, the chatbot group showed reduced anxiety symptoms, and user feedback was more positive with higher engagement.
Bendig E, et al.	Chatbots to Support Young Adults’ Mental Health: An Exploratory Study of Acceptability[2]	2019	Internet Interventions	Found that young adults view chat bots as acceptable and useful tools for supporting mental health, provided they ensure privacy and empathy.
Liu, H. et al.	Using AI Chatbots to Provide Self-Help Depression Interventions for University Students: A Randomized Trial of Effectiveness[3]	2022	Internet Interventions	A 16-week RCT showed that the AI chatbot XiaoNan was more effective than bibliotherapy in reducing depression and anxiety among university students. It also had higher adherence and improved therapeutic alliance. The study supports chatbot therapy as a scalable, low-cost mental health solution.
Sharma A, et al.	A Comprehensive Standardized Dataset on Mental Health Problems (MHPs) of University Students[1]	2023	PsyArXiv Preprints	Presented a large validated dataset (stress, anxiety, depression scores) from university students, enabling ML-based prediction models for early detection.
Smith J, et al.	Relaxation Techniques for Stress Relief[7]	2018	Harvard Health Publishing	Summarized effective relaxation techniques like deep breathing, progressive muscle relaxation, and mindfulness to reduce stress.

Table 2.2: Literature Review (Continued)

Author(s)	Title	Year	Source	Findings
Spitzer RL, et al.	A Brief Measure for Assessing Generalized Anxiety Disorder: The GAD-7[4]	2006	Archives of Internal Medicine	Developed and validated GAD-7, a 7-item screening tool for measuring anxiety severity with strong psychometric properties.
Kroenke K, et al.	The PHQ-9: Validity of a Brief Depression Severity Measure[5]	2001	Journal of General Internal Medicine	Introduced PHQ-9, a brief, validated tool for screening and monitoring depression in various settings.
Cohen S, et al.	Perceived Stress Scale-10 (PSS-10) Psychometric Properties[6]	1983	Journal of Health and Social Behavior	Developed PSS-10 to measure perceived stress, widely used in stress research for its reliability and validity.
Kowert R, Festl R, Quandt T	The Association Between Video Game Genres and Psychological Outcomes[16]	2023	Australasian Psychiatry	RPGs and music games linked with positive emotions and reduced stress; game genre plays a key role in mental health outcomes.
Torres-Rodríguez A, et al.	Commercial Video Games for Reducing Depression and Anxiety: A Narrative Review[14]	2021	JMIR Serious Games	Commercial video games are effective supplementary or standalone tools for managing depression and anxiety by promoting positive emotions and relaxation.
Andrea Zaccaro, et al.	How Breath-Control Can Change Your Life: A Systematic Review on Psycho-Physiological Correlates of Slow Breathing[8]	2018	Frontiers in Human Neuroscience	Slow and controlled breathing helps people feel more relaxed and calm. It improves heart and breathing health, helps the brain focus better, and lowers stress, anxiety, and negative emotions.
Russoniello, C. V., et al.	EEG, HRV and Psychological Correlates while Playing Bejeweled II: A Randomized Controlled Study[15]	2009	Journal of CyberTherapy & Rehabilitation	Playing a casual game like Bejeweled II improved mood, increased heart rate variability (HRV), and relaxed the nervous system—proving that such games can help reduce stress and anxiety.
Aliyari, H., et al.	Evaluation of Stress and Cognition Indicators in a Puzzle Game: Neuropsychological, Biochemical and Electrophysiological Approaches[17]	2022	International Journal of Environmental Research and Public Health	Playing a digital puzzle game reduced stress hormones (like cortisol), improved focus and brain activity, and helped users feel more relaxed compared to watching videos.

2.3 Games literature review

1. How Breath-Control Can Change Your Life: A Systematic Review on Psycho-Physiological Correlates of Slow Breathing

- In the article **How Breath-Control Can Change Your Life** by Zaccaro et al. (2018) [8], the authors explain that slow breathing reduces stress and anxiety by improving heart rate, calming the nervous system, and enhancing brain relaxation and concentration, while also making individuals feel less anxious, more relaxed, and more alert.
- We applied this concept in our project by developing a guided breathing animation in a 4-4-6 (inhale, hold, exhale) pattern and a collection of short meditations. These are tools that have the same breathing techniques as discussed in the paper. With these features, our system can assist students to relax, feel less stressed before exams and stress less easily. This study helps to prove that our practices are efficient and useful.

2. EEG, HRV and Psychological Correlates while Playing Bejeweled II: A Randomized Controlled Study

- The article EEG, HRV and Psychological Correlates during Bejeweled II game by Russoniello et al. (2009) [15] reveals that a simple game, such as Bejeweled II, can be used to alleviate stress and make one feel better. The researchers measured brain activity (EEG), and heart rate measurements (HRV) to demonstrate that the game enabled people to feel less anxious and more relaxed. It reveals that fun games do not need to be heavy and serious to relax the nervous system and enhance the emotional health..
- The idea is the same in our Bubble Pop Game. It is easy, colorful, and just like Bejeweled II, it is easy to play. It provides the user with a brief psychological release which makes them feel more relaxed, particularly when they are under study strain or when they are stressed. The paper upholds that games such as ours would make good instruments to reduce stress and enhance concentration in students.

3. Evaluation of Stress and Cognition Indicators in a Puzzle Game: Neuropsychological, Biochemical and Electrophysiological Approaches

- The article by Aliyari and others (2022) [17], titled Evaluation of Stress and Cognition Indicators in a Puzzle Game, describes the process of reducing stress and improving the focus of the brain due to playing the puzzle game. The researchers monitored brain activity, the levels of stress hormone and attention during and after playing. Individuals who played the game were less stressed, more focused, and less stressed

compared to those that merely watched videos. This demonstrates that peaceful puzzle games may be beneficial to mental health.

- And just like with our Relaxing Puzzler game. It operates on soft colors, relaxing music and easy logic games, to allow the students to be relaxed and clear their minds. Stress can also be mitigated in our game especially on exam day or when an individual has much to complete like in studying. It gives the students a short rest to refresh and regenerate. The research proves the fact that our game really can help students to overcome stress in a healthy way.

4. Relaxation Techniques for Stress Relief

- The paper by Smith J. et al. (2018) [7], "The article titled Relaxation Techniques for Stress Relief, which was released by Harvard Health Publishing, emphasizes the efficacy of some relaxation techniques including deep breathing, progressive muscle relaxation, as well as mindfulness in alleviating stress and improving the emotional state of an individual. Inspired by these findings,
- Here, I have incorporated the rhythmic movement and consciousness exercises in my project by using professionally developed games with relaxing activities such as running, walking, swimming, dancing, and climbing. These actions are one of those that cause a relaxation effect due to repetitive and flowing movement and conscious involvement. Since the users will be engaged in these activities in the game, it is probable that they will feel calm and relieved, which is one of the relaxation effects that will be discussed in the paper.

2.4 Current System Research

2.4.1 Youper

Youper is an artificial intelligence-based chatbot that can track the emotional well-being of users and support them with the help of psychological methods such as Cognitive Behavioral Therapy (CBT) and mindfulness. It assists users to monitor their mood in the long-term and provides exercise in meditation and self-help to deal with anxiety and depression. Nevertheless, in comparison to our suggested system, Youper does not offer interactive stress-relief games or real-time relaxation exercises whereby users are involved in alleviating stress right after assessment.

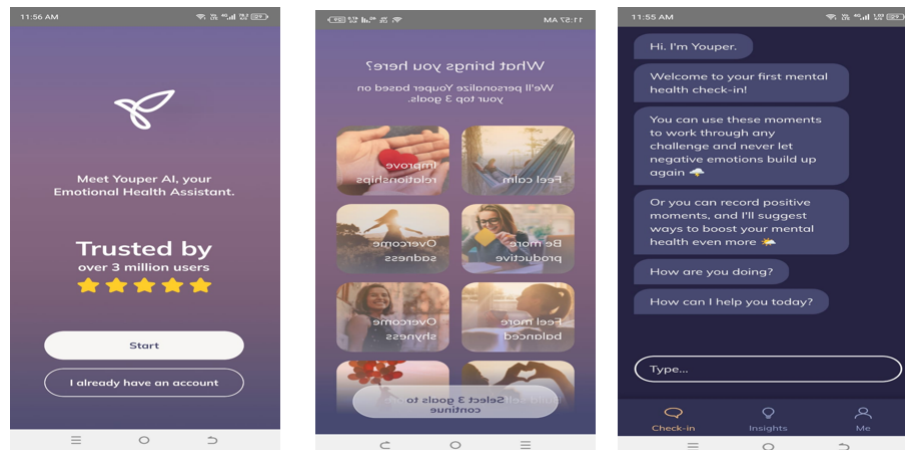


Figure 2.1: Youper App Interface

2.4.2 Wysa

Wysa is an artificial intelligence-based mental health chatbot, which provides evidence-based therapeutic help through Cognitive Behavioral Therapy (CBT) and mindfulness and meditation techniques. It gives users a secure place to share their emotions and will take them through self-help features, such as breathing, sleep, and mood-tracking. Wysa also has professional human coaches as an additional service. But in their case, Wysa does not provide interactive stress relieving games or integrate standardized mental health testing with real time relaxing exercises to make the experience more interactive and all rounding to students.

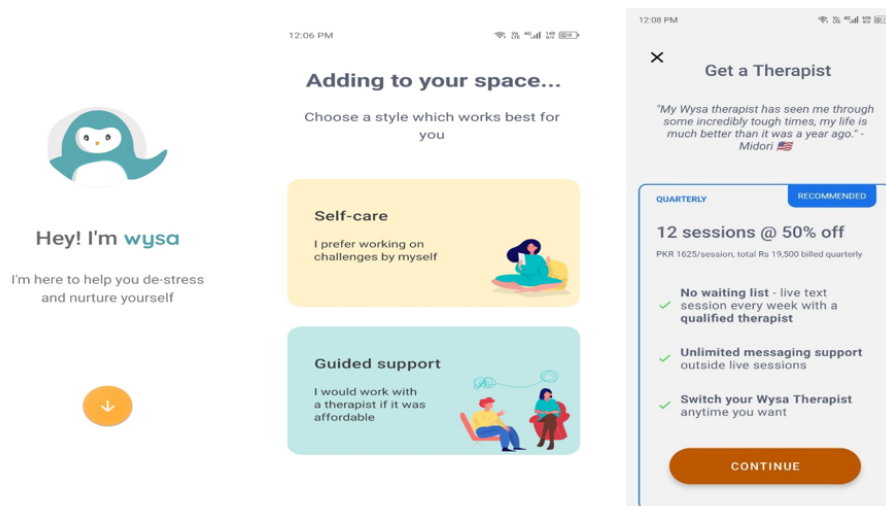


Figure 2.2: Wysa App Interface

2.4.3 Leora

Leora is an AI chatbot with NLP-based conversational support to overcome stress, anxiety, and depression, as well as, provide coping strategies and self-care tips. Although it will increase access to mental health assistance, it lacks stress-relief games or standardized tests such as PSS, GAD-7, and PHQ-9 that our system incorporates to make the student support tool more engaging and measurable.

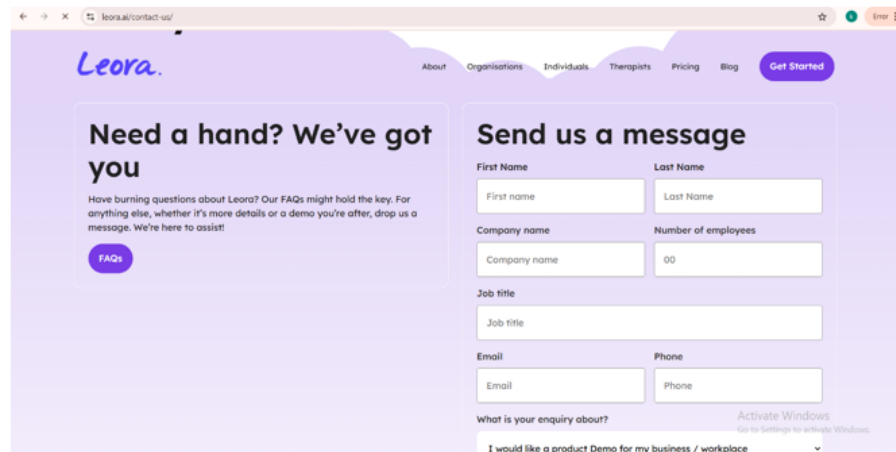


Figure 2.3: Leora Interface

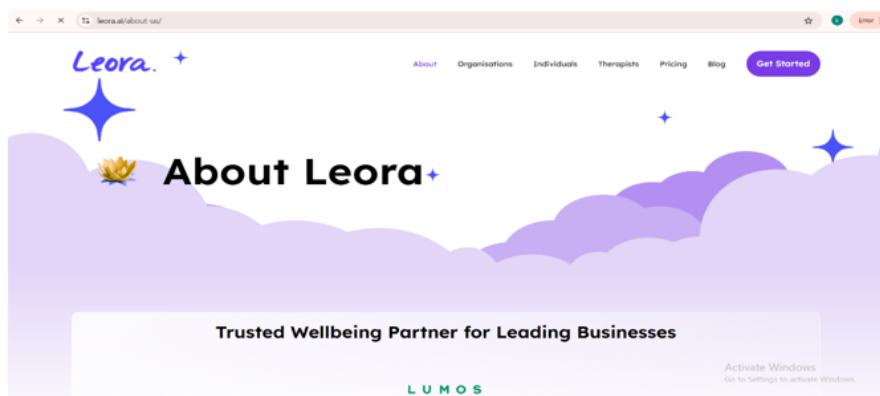


Figure 2.4: Leora Interface 2

Chapter 3

Requirement Specifications

3.1 Existing System

Over the years, a number of artificial intelligence-based mental health applications have been developed such as Wysa, Youper, and Leora[12]. The objective of these apps or applications is to offer chatbot-based psychological support based on the principles of mindfulness-based interventions Cognitive Behavioural Therapy (CBT). Despite their usefulness in the general population, they have not yet had an equally positive impact on university students, who seem to be unaware about educational-situational factors and strategies of engagement..

3.1.1 Limitations of the Existing System

The existing AI-based mental health applications, while beneficial for general users, present several significant limitations when it comes to addressing the specific needs of university students:

- Lack of interactive stress-relief games or engaging activities.
- Absence of integrated standardized mental health assessments (PSS, GAD-7, PHQ-9).
- Limited personalization based on student demographics or academic challenges.
- No real-time stress level tracking or reassessment features.
- Do not offer recommendations for professional psychological help within the university.
- Often rely only on text-based interventions, which may not appeal to all users.

3.2 Proposed System

The AI-Based Student Stress Management system seeks to give a fully-fledged and interactive mental health support system to university students. It is a combination of mental

health evaluation through machine learning, engaging stress-relief games, and an artificial intelligence-powered chatbot that provides real-time support and relaxation methods and allows the users to book the appointment with the particular doctors of the Bahria University well being center.

3.2.1 The Proposed System Overcomes Existing System Limitations

The proposed AI-Based Student Stress Management system addresses the identified limitations of existing systems through the following innovative features:

- Includes scientifically validated mental health assessments (PSS, GAD-7, PHQ-9).
- Offers engaging stress-relief games that provide cognitive distraction and mood elevation.
- Provides real-time severity classification (Low, Moderate, High) for stress, anxiety, and depression.
- Features an AI chatbot that offers coping strategies, recommends professional help within the university, and is trained on DSM-5 criteria and therapy resources to provide accurate, evidence-based support to students.
- Allows users to track their stress levels before and after activities.
- Ensures privacy by not collecting any personal identifiable data from users.

3.3 Requirements Specifications

The system requirements are broken down into non-functional and functional requirements to make the solution effective and user friendly. The functional requirements identify the exact features and functions that the system should execute to achieve the requirements of the university students who need support in stress management. The non-functional requirements are concerned with the general quality, security, performance, and usability of the system in order to give a smooth user experience. The system tries to provide a secure, convenient, and interactive platform to support student mental health by treating both categories.

3.4 Functional Requirements

3.4.1 Login and Registration

- The system allows users to register by providing their First Name, Last Name, Email, Phone Number, and Password through a registration form.

- The system securely stores user data, using encryption for passwords and validating email and phone formats during registration.
- The system allows users to log in using their registered email and password, granting access to their personalized dashboard upon successful authentication.
- The system provides a password recovery option, enabling users to reset their password through some questions asked that are security questions.

3.4.2 Survey Assessment & Data Collection

- The system includes a built-in survey module that administers standardized stress assessment questionnaires, such as the Perceived Stress Scale (PSS), GAD generalized anxiety disorder, and PHQ- for depression to evaluate students' mental well-being.
- These surveys use Likert-scale questions and are designed for ease of use across devices.
- Responses are securely stored and linked to individual user profiles for tracking stress levels over time and for training the machine learning model.

3.4.3 Data Collection

- Data is collected from multiple sources including survey responses, chatbot interactions, user feedback, and activity patterns within the platform.
- This multi-source data is useful in the construction of an entire user profile.
- All the gathered information is saved in a safe database and the users are well informed of the use which means that their information is private and can be used in analysis and prediction.

3.4.4 Data Analysis

- Analysis of the collected data is done with the help of the statistical methods and machine learning methods that help to identify patterns of stress.
- The system applies this analysis as personalized feedback, as well as recommending the doctor and psychologist who are in university (Behria)
- This facilitates early intervention and ongoing research of the mental health of the students.

3.4.5 Mental Health Classification

Three established psychological test scales are used in the system to identify the mental status of students in terms of mental health:

Table 3.1: Mental Health Classification Criteria

Mental Health Area	Scale	Score Range	Classification
Stress	PSS	0 - 13	Low Stress
		14 - 26	Moderate Stress
		27 - 40	High Stress
Anxiety	GAD-7	0 - 4	Minimal Anxiety
		5 - 9	Mild Anxiety
		10 - 14	Moderate Anxiety
		15 - 21	Severe Anxiety
Depression	PHQ-9	0	No Depression
		1 - 4	Minimal Depression
		5 - 9	Mild Depression
		10 - 14	Moderate Depression
		15 - 19	Moderately Severe Depression
		20 - 27	Severe Depression

The three assessment instruments, which are the Perceived Stress Scale (PSS) to measure stress levels, the Generalized Anxiety Disorder 7-item (GAD-7) scale to assess the symptoms of anxiety, and the Patient Health Questionnaire-9 (PHQ-9) scale to detect the signs of depression, are all standard assessment methods of mental health screening in the industry. Their wide use in both clinical and research settings is the testament to their reliability and effectiveness in identifying the problem of mental health in a diverse range of demographics.[6, 5, 4].

3.4.6 Interactive Stress-Relief Games

- The system provides a collection of interactive stress relieving games that are designed to reduce anxiety and increase the mood of the users.[16].
- Some of the fascinating mental exercises that the games offer as part of their stress-reduction resources include puzzles, breathing exercises, and memory games and relaxation challenges among many others that users can access and play anytime using their dashboard.

3.4.7 Student Stress Assessment

- Combining responses of surveys with smart analyses, the system estimates the level of stress in students.
- It evaluates stress indicators on the basis of proven psychological questionnaires and the accuracy has been enhanced more through machine learning algorithms that predict the level of stress of each individual on the basis of behavioural data and user inputs.
- A student is presented with the results of the assessment and individualised recommendations that are categorised into stress levels (e.g., low, moderate, and high).
- This would provide a possibility of continuous monitoring of mental health and early intervention.

3.4.8 AI Chatbot Support

- The system offers psychological support to users through an artificially intelligent chatbot via text-based communication.[2].
- The chatbot recommends stress coping skills, relaxation, and positive reinforcement to overcome stress, anxiety, and depression.
- Some of the credible mental health resources that have been employed to train the AI model include the DSM-5 (Diagnostic and Statistical Manual of Mental Disorders) and other evidence-based resources regarding stress, anxiety, and depression.
- The chatbot (available 24/7) refers users to the necessary resources or specialist help when it detects signs of severe distress in a user during their dialogues.

3.4.9 Recommendation for Professional Help

- All the details regarding the existing university psychologists (including their names, phone numbers, the office schedule, and the booking process) are provided on a separate Professional Help page.
- In case the chatbot with AI-based effects notices evidence of severe mental health issues or emergencies during a conversation, it will suggest that the client seek professional help.
- The system has links or contact forms where someone is able to easily book an appointment and to make a contact with the counselling services of the university.

3.4.10 Mental Health Reassessment

- After utilising the stress-relieving games and support resources, users can reevaluate their levels of stress, anxiety, and depression.
- Reassessment is performed by having users refill the PSS, GAD-7, and PHQ-9 surveys to measure any changes in their mental health status.
- The system compares the new assessment scores with previous results and displays the difference or progress on the user's dashboard.

3.4.11 Report Generation

- Full User Data- Every report includes the history of personal stress and activities of the student.
- Assessment Results - consists of stress testing results, survey results, and AI analysis.
- Appointments Sessions - Has a record of counseling session, appointment and follow-ups.
- AI Recommendations Customized recommendations, coping mechanisms and relaxation.
- Progress Tracking The Demonstrates stress level changes or progress.
- Download & Sharing – Reports can be exported in PDF for students and counselors.

3.4.12 Administrative Functions

- Activity Monitoring - Admin has the option to see all the activities done by the user such as stress tests, sessions and progress.
- Management Control - the user data, appointments and recommendations can be managed by the management.
- Performance Tracking Administration will be able to check the general student performance and system usage to optimize the platform.

3.5 Non-Functional Requirements

- **Privacy Protection** – Anonymity of the user should be strictly maintained throughout the system interactions and any personally identifiable information should not be collected or retained.

- **User-Friendly Interface** – The system can be said to have an easy interface which will be customized to accommodate college students with various technical expertise.
- **Real-Time Performance** – In order to ensure a perfect user experience, the system will offer real-time chatbot replies, instant feedback, and mental health suggestions.
- **24/7 Availability** – The system will be consistently online to ensure that the students have 24/7 access to mental health assistance whenever they feel they need it, at any given time of the day or night.
- **Accessibility Compliance** – The system should be created to accommodate students with disabilities, and therefore its design should be done with this consideration to ensure that it follows the accepted accessibility guidelines.
- **System Scalability** – The system should be in a position to support multiple users simultaneously without slowing down or low performance .

3.6 User Requirements

- **User Registration and Login**
 - To create a user account one needs a secure password, phone number, email address, and name.
 - A secure login will allow one to access a customised dashboard and get all of the features in it.
 - In case of lost credentials, it has an option of password recovery through registered email.
- **Self-Assessment**
 - Availability of validated psychological surveys such as PSS (Perceived Stress Scale) of stress, GAD-7 of anxiety and PHQ-9 of depression.
 - The results are immediately grouped into three different categories, which are low, moderate, and high as the survey is completed .
- **AI Chatbot Support**
 - 24/7 Chatbot access driven by AI for instant mental health assistance.
 - evidence-based relaxation methods, motivational messages catered to each person's needs, and customised coping mechanisms.
 - When high stress levels or emergency situations are detected, an intelligent chatbot makes recommendations for university psychologists.

- **Interactive Stress-Relief Tools**

- access to a variety of stress-relieving games and activities, such as memory-boosting games, puzzles, and guided breathing techniques.
- After using stress-relieving techniques, there is the option to reevaluate mental health status in order to gauge effectiveness.

- **Professional Help Recommendation**

- A system that automatically suggests professional help based on an assessment of the severity of mental illness.
- full listing of psychologists' contact details, office hours, and names of practitioners.
- Direct booking options and contact mechanisms for easy appointment scheduling.

- **Reassessment**

- After using the support features and stress-relieving tools, the system asks for a mental health reassessment.
- thorough comparison of fresh test results with earlier findings to monitor development and progress.

- **Privacy and Anonymity**

- Complete security that assures that there is no storing of personally identifiable information on the platform.
- All user input and user interactions are secured through procedures and full data encryption.

- **Accessibility**

- compatibility with all devices like PCs, tablets and smart- phones.
- user-friendly, responsive interface design, depending on the size of the screen and method of input.
- Full compliance with the accessibility requirements in order to ensure the usability of learners with different needs and abilities.

- **Availability**

- System available 24/7 online to offer round-the-clock mental health care to the students whenever they are in need.

3.7 Use Case Diagram

In this section, the UML Use Case Diagram of the AI-Based Student Stress Management System is presented and it highlights the in-depth interactions between the system and the student user through the various system functions.

3.7.1 AI-Based Student Stress Management System Use Case

The overall process and interaction with the users regarding the AI-Based Student Stress Management System is represented in the use case diagram below. It also shows interrelationships among different use cases like extend, include and sequential flows.

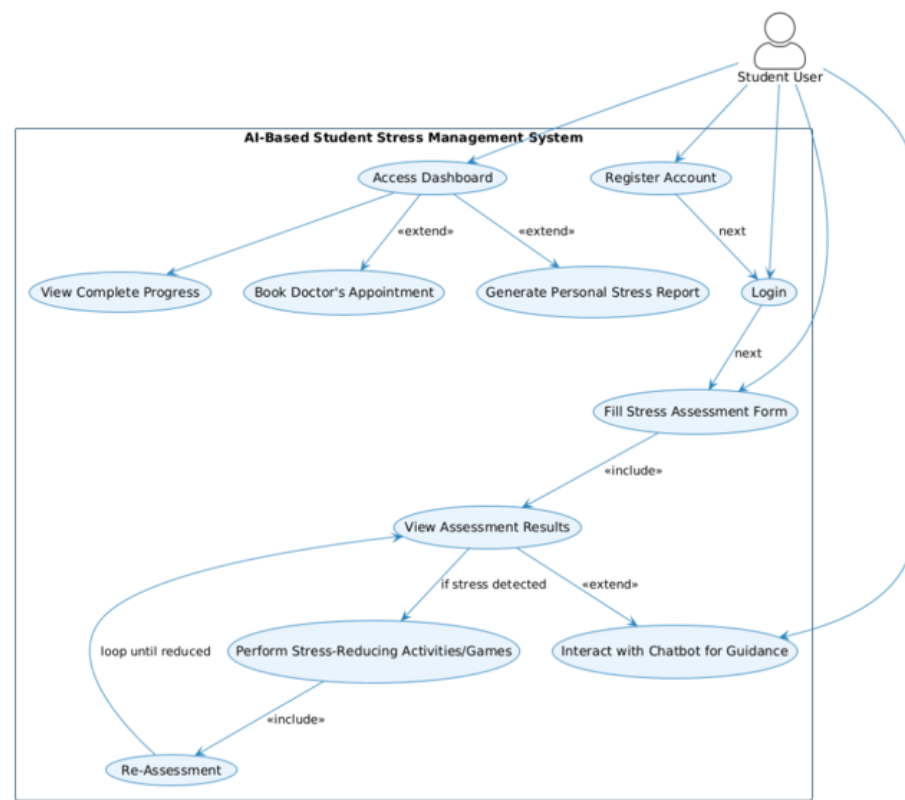


Figure 3.1: System Use Case Diagram

The use case diagram shown in Figure 3.1 illustrates the use case diagram of the AI-Based Student Stress Management System and indicates the overall functionality of the system. The diagram illustrates:

- **Primary Actor:** Student User interacting with all the system functions
- **Core Use Cases:**
 - Register Account - Registration of a user

- Access Dashboard - the main center of the system capabilities
- Login - Authentication of the user and access to the system
- Fill Stress Assessment Form - Psychiatric examination course
- View Assessment Results -Presentation of assessment results
- - Perform Stress-Reducing Activities/Games
- Interact with Chatbot for Guidance -Intelligent Assistance
- Re-Assessment - Follow up evaluation process

• **Extended Features:**

- Full Progresses - Tracking of full progress
- Appointment booking of Book Doctor - professional consultation
- Create Personal Stress Report - extensive progress records

3.7.2 Admin Use Cases

The management aspect of the AI-Based Student Stress Management System provides full-fledged comprehensive oversight and management capabilities for the Well-Being Center staff. This use case diagram illustrates the administrative functions required for effective system management and student support coordination.

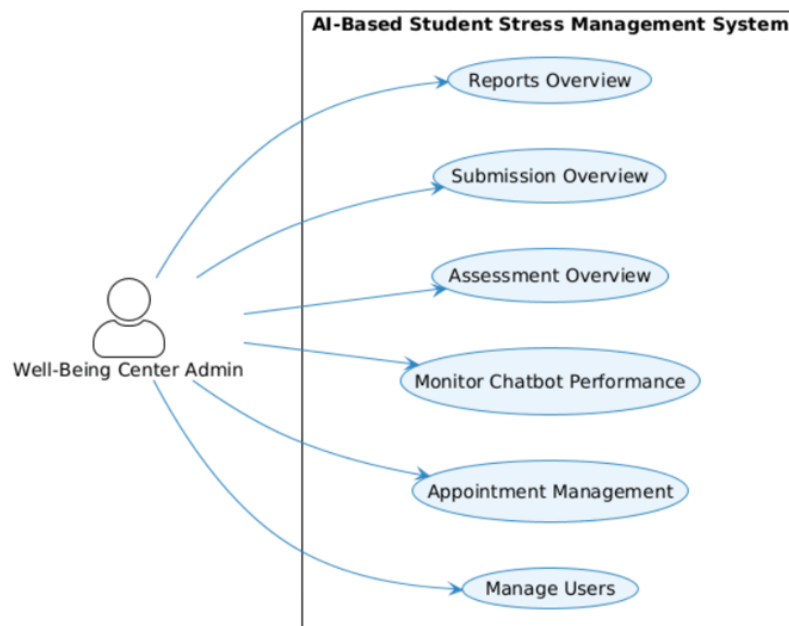


Figure 3.2: Administrative Use Cases

The administrative use case diagram shown in Figure 3.2 the administrative use case diagram, which illustrates the entire administrative features of the well-being center administrators. The system offers two administrative modules:

- **Primary Actor:** Well-Being Center Administrator that is in charge and controls the whole system
- **Monitoring & Overviews Module:**
 - **Reports Overview** - complete access to all the analytics and reports generated by the system
 - **Submission Overview** - monitoring of all student submission rates and assess submissions
 - **Assessment Overview** - Analysis of test results, trends and patterns among the students
 - **Monitor Chatbot Performance** -Observing AI chatbot communication, effectiveness and possible improvement opportunities
- **User & Appointment Management Module:**
 - **Appointment Management** - scheduling, rescheduling and monitoring student counseling appointments.
 - **Manage Users** -User account management, access control and student profile management.
- **Administrative Capabilities:**
 - Real time monitoring system performance and interaction with the system.
 - Information processing to make informed decisions.
 - Appointment and the coordination of resources.
 - Account management and support.
 - Increasing the efficiency of the system and monitoring the maintenance.

This administrative arrangement will assist the staff at the Well-Being Center to track student mental health patterns, utilize resources effectively, and provide the staff with the necessary support in due time. The modular design will enable the administration to increase and evolve as the system adjusts to the needs of the students.

3.7.3 Use Case Specifications

This section provides specifications of every use case in detail. It contains preconditions, basic flows, alternative flows and post conditions. All of the use cases are written in a table to make the presentation complete.

3.7.3.1 Login

The use case of the Login demonstrates the simple authentication process, which enables students to gain access to the AI-Based Student Stress Management System and its various features with great security.

Table 3.2: Use Case - Login

Attribute	Description
Use Case ID	UC-01
Use Case Name	Login
Actors	Student
Description	Enables students to log in securely to access stress management features.
Preconditions	Student has valid credentials.
Basic Flow	1. Student opens login page. 2. Enters credentials. 3. System verifies and grants access.
Alternative Flows	1. Invalid credentials → Error message shown.
Post conditions	Student is authenticated and redirected to main page.
Frequency of Use	Very Frequent
Priority	High

3.7.3.2 Registration

The registration process enables new students to create an account by providing their personal details and security information. The system verifies the input, checks for existing users, and securely stores the data using hashing techniques. Upon successful registration, the student is redirected to the login page to access the system.

Table 3.3: Use Case - Registration

Attribute	Description
Use Case ID	UC-02
Use Case Name	Registration
Actors	Student
Preconditions	Student is not already registered.
Basic Flow	1. Open registration page. 2. Enter details and submit. 3. System validates and stores data. 4. Redirect to login page.
Alternative Flows	Invalid data → Error message shown.
Post conditions	Account created successfully.
Frequency	Moderate
Priority	High

3.7.3.3 Assessment - Stress

Assessment use case is the main capability of the system as it allows performing a full mental health examination using various proven psychological assessment instruments with the help of artificial intelligence analysis.

Table 3.4: Use Case - Assessment

Attribute	Description
Use Case ID	UC-03
Use Case Name	Assessment – Stress, Anxiety, depression
Actors	Student
Description	Evaluates stress levels using PSS, GAD-7, PHQ-9, and AI model.
Preconditions	Student logged in and submitted questionnaire.
Basic Flow	1. Student completes assessment. 2. System classifies stress level.
Alternative Flows	1. Partial form → notify to complete.
Post conditions	Stress score generated and stored.
Frequency of Use	Frequent (per session)
Priority	High

3.7.3.4 Game Recommendation

The Game Recommendation use case offers intelligent therapeutic intervention using interactive stress relief programs, which offer students interesting ways of coping and lowering their stress levels depending on their evaluation.

Table 3.5: Use Case - Game Recommendation

Attribute	Description
Use Case ID	UC-04
Use Case Name	Game Recommendation
Actors	Student
Description	Suggests relaxing games to reduce stress levels.
Preconditions	Assessment shows mild stress.
Basic Flow	1. System shows game and activities options. 2. Student plays.
Alternative Flows	1. Student skips → returns to dashboard or main page. Also the user can move to the chatbot page
Post conditions	Game session data logged.
Frequency of Use	Moderate
Priority	Medium

3.7.3.5 AI Chatbot

Emotional support and guidance through conversational AI The case of the AI Chatbot offers instant, readily available emotional support and guidance as the initial contact in therapeutic intervention by addressing mental health needs of students.

Table 3.6: Use Case - AI Chatbot

Attribute	Description
Use Case ID	UC-05
Use Case Name	AI Chatbot
Actors	Student
Description	Provides initial emotional support and guidance using conversational AI.
Preconditions	Student must be logged in.
Basic Flow	1. Student opens chatbot. 2. Asks a question. 3. Chatbot responds with support or suggestions.
Alternative Flows	1. No internet → fallback message.
Post conditions	Student receives initial guidance or redirection to assessment.
Frequency of Use	Frequent
Priority	Medium

3.7.3.6 Data Collection

Data Collection use case involves the structured accumulation and data storage of user interaction of assessment responses and behavioral data that serves as the basis of AI-driven processing and custom-made mental health intervention.

Table 3.7: Use Case - Data Collection

Attribute	Description
Use Case ID	UC-06
Use Case Name	Data Collection
Actors	Student, Admin
Description	Collects user inputs, questionnaire responses, and session data.
Preconditions	Student uses chatbot or completes forms.
Basic Flow	1. Student interacts. 2. System stores responses. 3. Admin can view summary.
Alternative Flows	None
Post conditions	Data is available for training and analysis.
Frequency of Use	Frequent
Priority	High

3.7.3.7 Therapy Recommendation using Chatbot

Therapy Recommendation using Chatbot use case is a therapy-focused use case that utilizes artificial intelligence to deliver discussed therapeutic interventions and self-help in relation to the results of individual assessment and continuous interaction with the chatbot.

Table 3.8: Use Case - Therapy Recommendation using Chatbot

Attribute	Description
Use Case ID	UC-07
Use Case Name	Therapy Recommendation using Chatbot
Actors	Student
Description	Recommends online/self-help therapy for stress, anxiety and depression.
Preconditions	Assessment form filled.
Basic Flow	1. System shows therapy resources. 2. Student accesses sessions. 3. Also take recommendation from the chatbot.
Alternative Flows	1. Decline → log reason.
Post conditions	Progress tracked.
Frequency of Use	Moderate
Priority	High

3.7.3.8 Doctor Recommendation

The Doctor Recommendation use case offers important escalation measures to students that display high levels of stress and guarantee the relevant professional assistance in time with the help of university counseling and mental health services.

Table 3.9: Use Case - Doctor Recommendation

Attribute	Description
Use Case ID	UC-08
Use Case Name	Doctor Recommendation
Actors	Student
Description	Suggests contacting university counselor/doctor for high stress.
Preconditions	User should have account and he or she is allowed to book appointment.
Basic Flow	1. Contact options shown.
Alternative Flows	1. No action taken.
Post conditions	Referral recorded.
Frequency of Use	Medium
Priority	High

3.7.3.9 Reassessment

The Reassessment use case offers an essential system of feedback that allows the students to evaluate the efficiency of therapeutic interventions and trace their success in clearing of stress and enhanced mental condition.

Table 3.10: Use Case - Reassessment

Attribute	Description
Use Case ID	UC-09
Use Case Name	Reassessment
Actors	Student
Description	Allows students to retake assessment after intervention.
Preconditions	One of the recommendations was used.
Basic Flow	1. Student retakes the assessment. 2. System evaluates again.
Alternative Flows	1. Skipped → send reminder.
Post conditions	New stress level recorded.
Frequency of Use	Depends on improvement cycle
Priority	High

3.7.3.10 Report Generation

Report Generation use case will allow thorough documentation and analysis of mental health progress of students, as well as in-depth insights both to track them personally and consult with the professionals.

Table 3.11: Use Case - Report Generation

Attribute	Description
Use Case ID	UC-10
Use Case Name	Report Generation
Actors	Student
Description	Generates comprehensive reports containing assessment results, progress tracking, and intervention history.
Preconditions	Student has completed at least one assessment cycle.
Basic Flow	1. Student requests report. 2. System compiles data. 3. Report generated in PDF
Alternative Flows	1. Insufficient data → notify minimum requirements.
Post conditions	Report available for download and sharing.
Frequency of Use	Occasional
Priority	Medium

3.7.3.11 User Logout

The logout feature ensures secure session termination for the user by clearing all stored session data. It prevents unauthorized access by redirecting the user to the login page after logout. This functionality maintains security by disabling access to protected pages without re-authentication.

Table 3.12: Use Case - Logout

Attribute	Description
Use Case ID	UC-11
Use Case Name	User Logout
Actors	Student
Preconditions	User must be logged in with an active session.
Basic Flow	1. User clicks logout button. 2. System clears session data. 3. User is redirected to login page.
Alternative Flows	System error → Error message shown.
Post Conditions	Session data cleared, user logged out successfully.
Frequency	Frequent
Priority	High

3.7.3.12 Appointment Booking

The appointment booking system enables users to schedule consultations with available doctors. It validates slot availability, prevents duplicates, and enforces monthly booking limits per doctor. Upon successful submission, the appointment is stored with a Pending status, and the user receives confirmation.

Table 3.13: Use Case - Appointment Booking

Attribute	Description
Use Case ID	UC-12
Use Case Name	Appointment Booking
Actors	Student
Preconditions	User must be logged in; doctors list and slots must be available.
Basic Flow	1. Open appointment booking page. 2. User selects doctor and fills required details. 3. System checks validation and slot availability. 4. Appointment stored with <i>Pending</i> status. 5. Confirmation message shown.
Alternative Flows	Duplicate slot → Error message. Monthly limit exceeded → Booking denied.
Post Conditions	Appointment successfully created with proper status.
Frequency	Moderate
Priority	High

3.7.3.13 Admin Login

This use case ensures secure authentication of administrators using a role-based login system. Only valid admin credentials allow access to the dashboard, while invalid inputs trigger error messages. It strengthens system security through session control and restricted access to sensitive functionalities.

Table 3.14: Use Case - Admin Login

Attribute	Description
Use Case ID	UC-13
Use Case Name	Admin Login
Actors	Admin
Preconditions	Admin account exists and admin login page is loaded.
Basic Flow	1. Open admin login page. 2. Enter email and password. 3. System verifies credentials. 4. Redirect to admin dashboard.
Alternative Flows	Invalid credentials → Error message shown; no access granted.
Post Conditions	Admin is authenticated and session role is set to 'admin'.
Frequency	Moderate
Priority	High

3.7.3.14 Admin Dashboard Use Case

The Admin Dashboard enables administrators to efficiently manage users, appointments, and assessments through a centralized interface. It provides comprehensive control over system operations, including monitoring user activity, reviewing assessment results, and overseeing appointment scheduling. The dashboard also offers access to secure API endpoints for retrieving real-time statistics, generating reports, and performing various administrative actions, helping administrators make informed decisions and ensure smooth system performance.

Table 3.15: Use Case - Admin Dashboard Management

Attribute	Description
Use Case ID	UC-14
Use Case Name	Admin Dashboard Management
Actors	Admin
Preconditions	Admin must be logged in with a valid session and database connected.
Basic Flow	1. Admin navigates to the dashboard. 2. System displays data overview including users, appointments, assessments, and chatbot ratings. 3. Admin accesses API endpoints to view statistics and perform management actions. 4. Admin can update records, delete users, and manage the status of appointments. 5. System confirms actions with success messages and refreshed data display.
Alternative Flows	Unauthorized access → Redirect to login page. Invalid operation → Error message displayed without affecting other data.
Post Conditions	Dashboard shows updated statistics; user management and appointment status updates completed successfully.
Frequency	Frequent
Priority	High

Chapter 4

Design

The AI-Based Student Stress Management System is designed in a manner that guarantees a formal and scalable system that incorporates psychological tests, chatbots, stress-relieving games, and counseling suggestions. The design is modular hence the separation between the presentation, application, and database layers with the aim of enhancing performance and maintainability. Security, usability, and scalability were put into consideration to support several simultaneous users, as well as to secure sensitive student mental health data. With an approach based on the concept of systematic design, the system will successfully integrate an approach that incorporates artificial intelligence, database management, and psychology in dealing with the issue of stress among the students in an academic environment.

4.1 System Architecture

The AI-Based Student Stress Management System is based on a 4-Tier Architecture that is to deliver service of mental health support scalable, maintainable, and efficient. This is a type of architecture that provides easy separation of concerns and supports easy system maintenance, updates, and future upgrades without compromising optimal performance and security.

4.1.1 4-Tier Architecture Overview

The system follows a 4-Tier Architecture:

1. **Presentation Tier** – It offers the student with log in, surveys (PSS, GAD-7, PHQ- 9) results dashboard, games, chatbot, reports and reassessment, doctor appointments, report creation.
2. **Application Tier** – Application Tier flask based API with Authentication, Survey Processing, Prediction Engine, Recommendation Module (Therapy, Doctor, Games, Counseling), Chatbot Logic, Report Generator and API Gateway.
3. **Data Tier** – SQL Server Database with Users, Surveys, GameLogs, ChatLogs, Reports and Assessments.

4. **AI/ML Tier** – Pretrained ML models (Stress, Anxiety, Depression) using preprocessing (Scalers, Encoders).

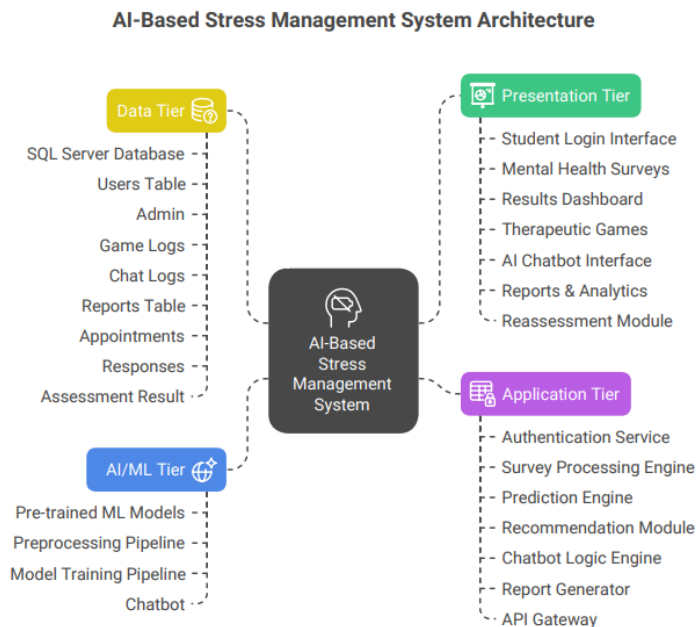


Figure 4.1: System Architecture

The architectural diagram shown in Figure 4.1 presents the architectural plan of the 4-tier architecture of the AI-Based Student Stress Management System. The diagram shows the interrelations quite clearly the Presentation Tier (green) with user interfaces, the Application Tier (purple) with business logic and API services, the Data Tier (yellow) with the SQL Server database with all required tables, and the AI/ML Tier (blue) with the intelligent analysis and prediction functions. This modular structure guarantees scalability, maintainability and effective flow of data in the system.

4.2 Design Constraints

4.2.1 Technical Constraints

- The system is cross-browser friendly (Chrome, Firefox, Edge, Safari) so that it can be as accessible as possible.
- An interactive user interface has been created to deliver convenient interactions between the desktops and mobile devices.

- Prediction cycle is optimized to take less than 5 seconds to be efficient to user.
- Flask SQL Server integration is applied with the help of pyODBC that provides a high degree of reliable and efficient connection to a database.

4.2.2 Security & Privacy Constraints

- User credentials have been encrypted through password hashing where Werkzeug Security has been used.
- The responses to the survey are anonymous and they are mapped with the userid rather than the identifiable information, so that user privacy is guaranteed.
- All database operations are done using parameterized queries to protect attacks on SQL.
- User data is confidential; it is there, and it is ethical to address the issue of mental health information.

4.2.3 Operational Constraints

- The system is initially deployed on a local server for testing and evaluation purposes.
- The machine learning models must have a 95 percent accuracy to guarantee a high-quality prediction.
- System performance is monitored continuously and scalability is kept in consideration in case it is to be deployed on cloud infrastructure in future.

4.3 Design Methodology

Such system was created based on the combination of Agile principles and Modular Design in order to provide flexibility, adaptability, and maintainability throughout project lifecycle.

4.3.1 Modular Design

The modules are: Authentication, Survey Handling, Prediction, Recommendation, Chatbot, Games, Reports.

To increase maintainability and reusability, the application was designed with modules that are independent, but they are interconnected:

- **Authentication** User registration and login.
- **Survey Handling** Survey Stress, anxiety and depression data collection.

- **Prediction** Machine learning model inference.
- **Recommendation** Individualized recommendations and materials.
- **Chatbot** AI-based chat support.
- **Games** Stress-relief interactive modules.
- **Reports** Analytical summary and counseling support.

4.3.2 Agile Prototyping

Agile prototyping was used with iterative sprint development: development was built up gradually and refined:

- **Sprint 1:** Survey + Prediction Module.
- **Sprint 2:** Chatbot to have a real-time interaction.
- **Sprint 3:** Stress-relief Games and Reassessment Characteristics.
- **Sprint 4:** Report Generation and Counseling Support Module.

Planning, development, testing and feedback incorporation in each sprint ensured that the needs of the users and project goals were always achieved.

4.4 System Activity Diagram

The system workflow is depicted in an in-depth activity diagram, which demonstrates the entire user experience and system interrelations in the AI-Based Student Stress Management System..

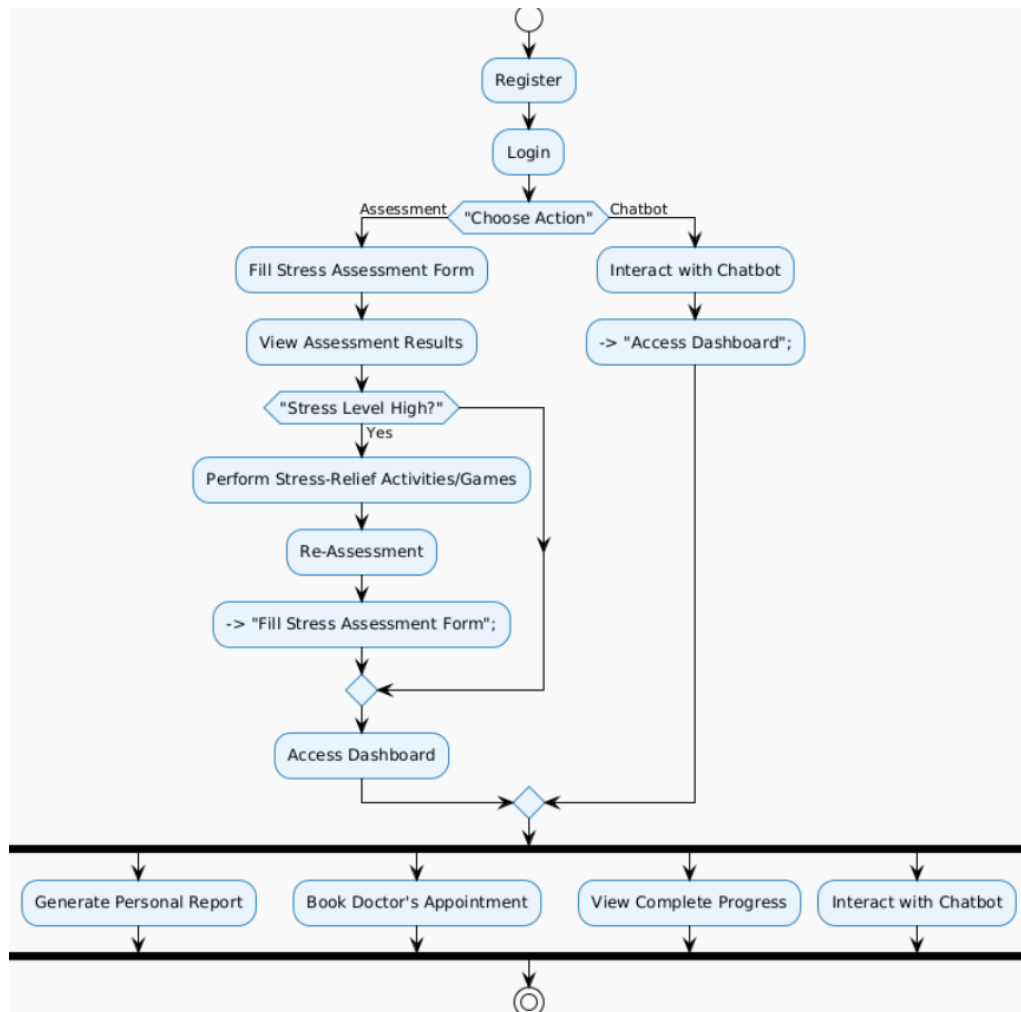


Figure 4.2: Activity Diagram

The activity diagram shown in Figure 4.2 illustrating the workflow of the AI-Based Student Stress Management System, starting with user registration and login, moving through the assessment process, and ending with various intervention options. The diagram shows decision points where users choose functions such as stress assessment, chatbot interaction, stress-relief activities, and dashboard access. The workflow follows a continuous cycle of assessment, intervention, and reassessment to ensure effective stress management. Key features include the stress-level assessment decision point, iterative reassessment, and the dashboard offering report generation, doctor appointments, progress tracking, and ongoing chatbot interaction.

4.4.1 Administrative Activity Diagram

The administrative part of the system has a developed workflow, which is aimed at helping the staff of Well-Being Center to provide effective management of student mental health services.

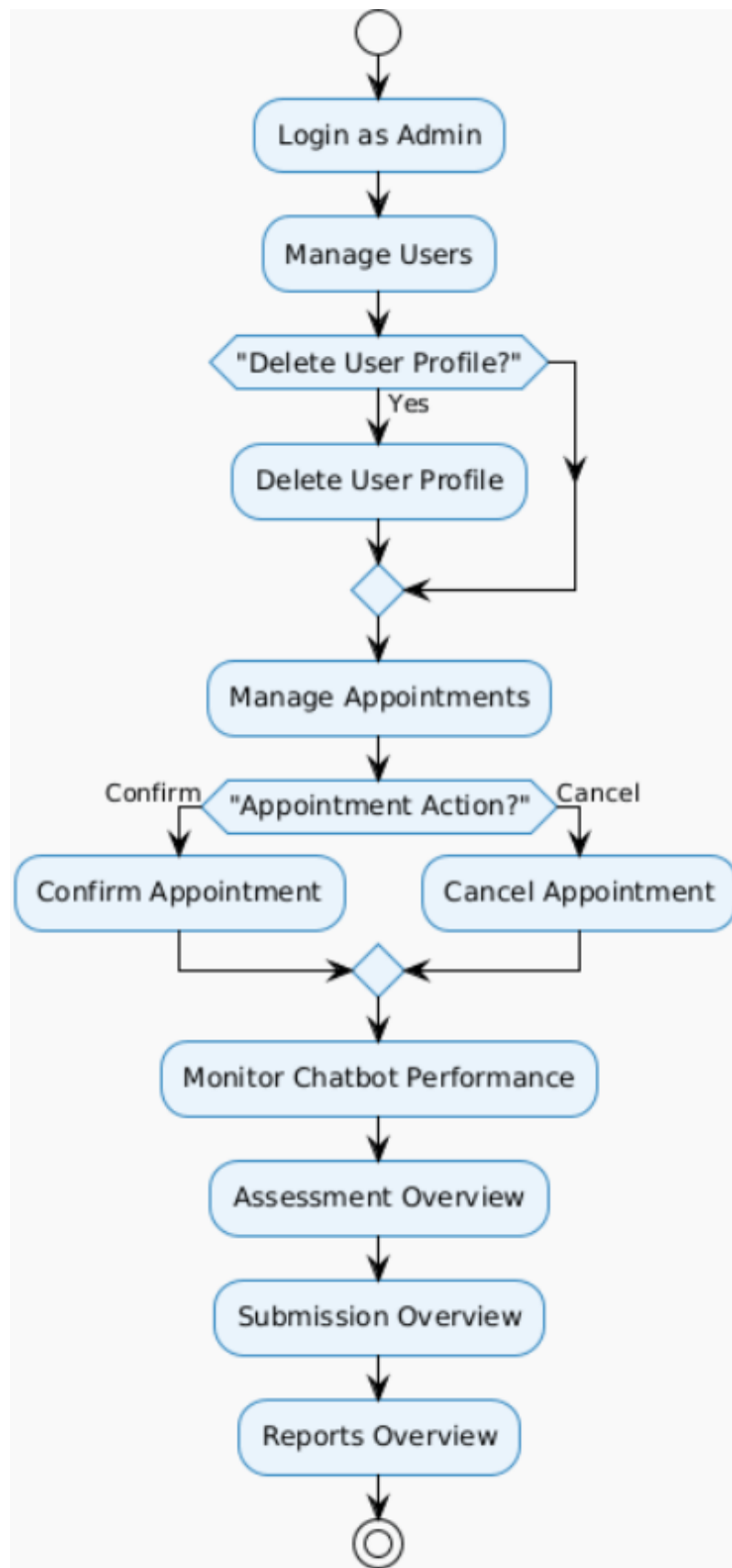


Figure 4.3: Admin Activity Diagram

The administrative activity diagram shown in Figure 4.3 shows the overall workflow that the administrators of Well-Being Center are able to do. The diagram starts with the verification of the administrator and moves all the way to the user with the ability to manage the user such as the deletion of the profile. The work process includes appointment control with a decision point of confirming or canceling appointments and then regular monitoring functions. The main administrative aspects are chatbot performance monitoring, assessment overview in order to track student evaluation patterns, submission overview in order to monitor system use age, and reports overview in order to provide the overall analytics. This systematic strategy makes sure that the administrators are able to effectively tackle the individual cases of the students and at the same time the performance indicators of the system.

4.5 High Level Design

High Level Design (HLD) is the system design which provides a rough sketch of the structure of the system. It is based on the identification of the main modules, the interaction between modules and the data flow between the modules. Instead of going into technicalities, HLD develops a larger picture of how the system will operate and the stakeholders are able to familiarize themselves with the general architecture.

4.5.1 Component Diagram

The Component Diagram shows the major building blocks of the AI-Based Student Stress Management System, and its relation. It reveals the student modules, admin modules and back-end services, the roles are well divided and data flow within the system.

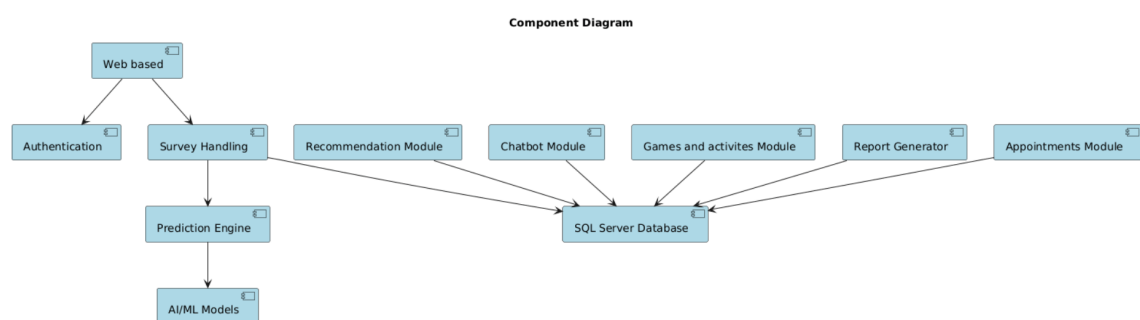


Figure 4.4: Component Diagram

The component diagram shown in Figure 4.4 illustrates, the AI-Based Student Stress Management System has a modular architecture. The diagram demonstrates that the Web-based interface is the main entry point which is connected to seven central modules: Authentication to provide secure access to users, Survey handling to technique psychological tests, Recommendation to provide personal recommendations, Chatbot to provide

conversational support, Games and Activities to provide stress-relief interventions, Report generator to detail the progress and Appointments to make a professional appointment. The Survey Handling module is a reference to the Prediction Engine, which applies AI/ML Models to the intellectual analysis. The central SQL Server Database connects all the modules and there is a smooth flow of data and integration of the system. This modelling architecture encourages serviceability, scalability and separation of concerns throughout the system architecture.

4.5.2 Deployment Diagram

The Deployment Diagram is used to indicate the way the AI-Based Student Stress Management System is configured and deployed. It displays the distribution of the various parts among various servers and their communication with one another in the production setup.

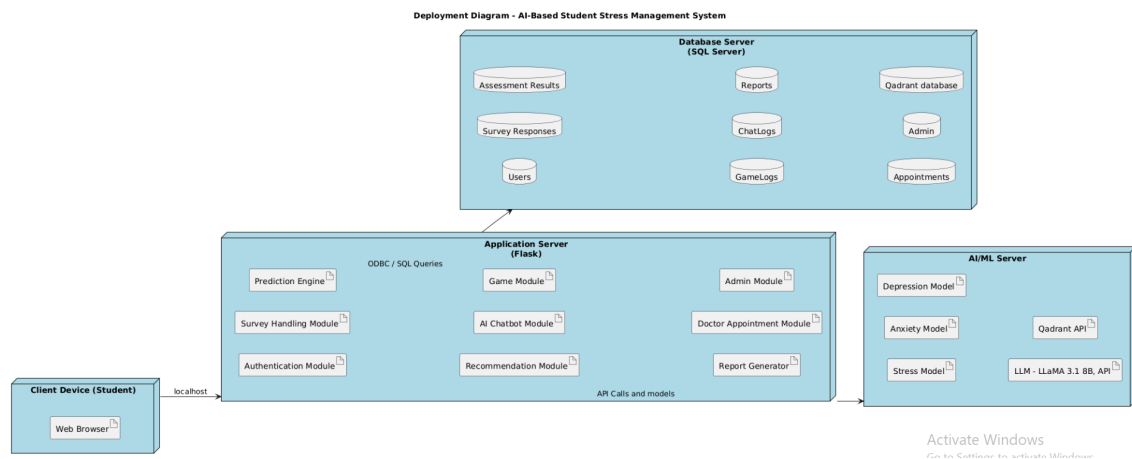


Figure 4.5: Deployment Diagram

The deployment diagram shown in Figure 4.5 is a deployment diagram that illustrates the overall deployment infrastructure of the AI-Based Student Stress Management System that exhibits the decentralized infrastructure of multiple special purpose servers.

4.6 Sequence Diagrams

This section presents step-by-step sequence diagrams demonstrating how the various components of the AI-Based Student Stress Management System interact in the realization of every key functionality. Every diagram displays the way actors and system modules communicate with one another.

4.6.1 Login Sequence

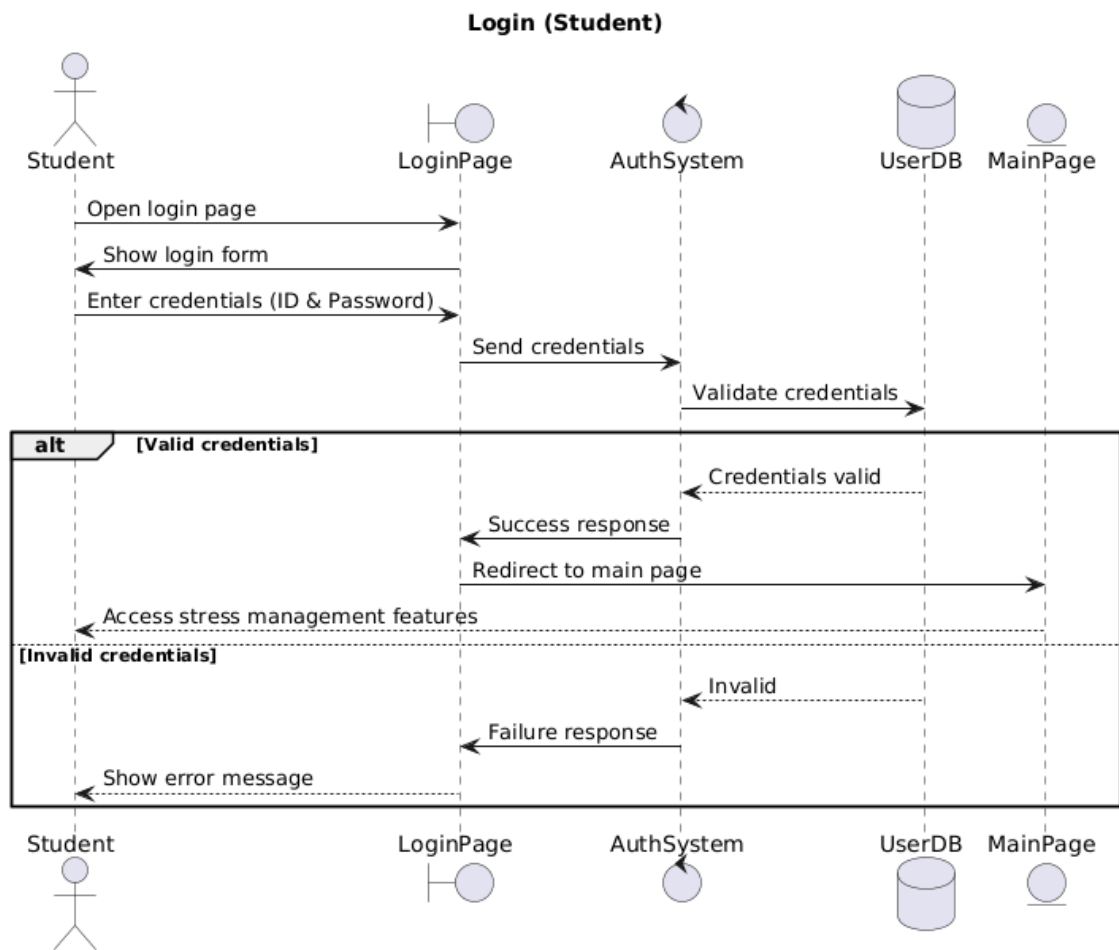


Figure 4.6: Login Sequence Diagram

Authentication process where students are required to key their credentials through the web interface is presented in the sequence diagram of the login. The system authenticates the user successfully and provides a secure session and checks the user credentials against the database. This process ensures that the user privacy and data protection standards are maintained and at the same time ensures that all the system features are accessed safely.

4.6.2 Assessment Sequence

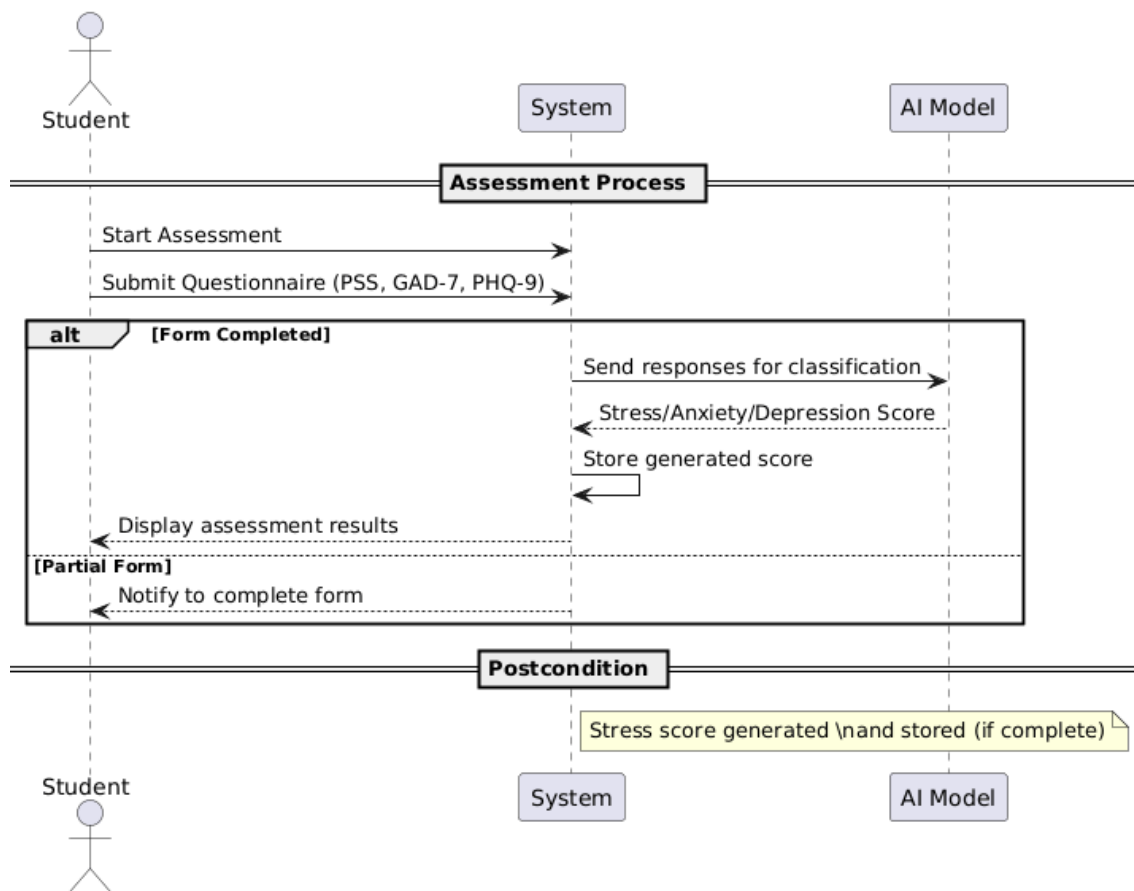


Figure 4.7: Mental Health Assessment Sequence Diagram

The evaluation process with the use of validated psychological scales (PSS, GAD-7, PHQ-9) portrays the complete process of the mental health examination. Assessment forms are completed by the students through the web interface. They are categorized with machine learning models to determine the levels of their stress, anxiety, and depression. The student will get personalized recommendations on intervention methods and the outcomes of the same, which are stored in the database.

4.6.3 AI Chatbot Interaction Sequence

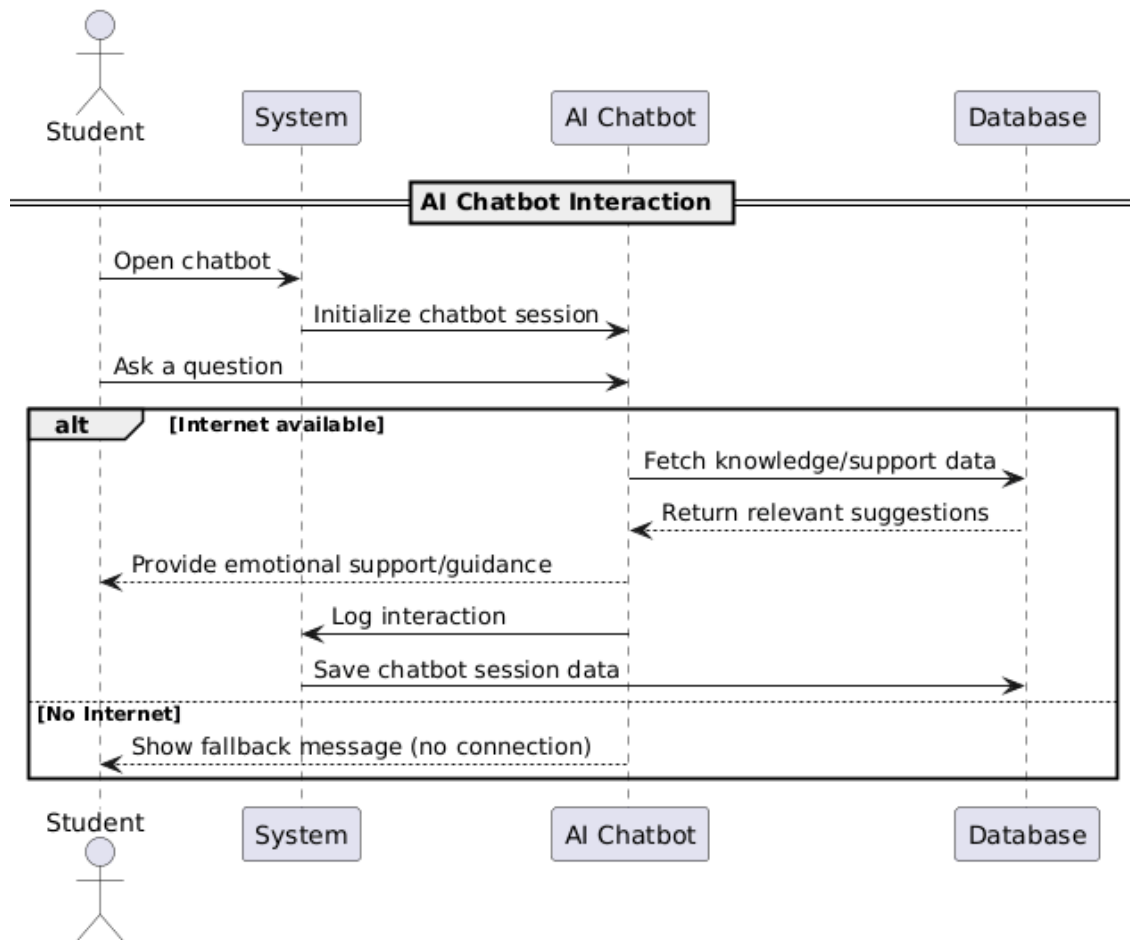


Figure 4.8: AI Chatbot Interaction Sequence Diagram

The chatbot conversation with the AI support system providing students with 24/7 mental healthcare is shown in the chain of the chatbot. The system involves the processing of natural language queries with the help of DSM-5 trained and resources models and provides professional referrals, relaxation methods, and evidence-based coping tactics. All the interactions will be documented to further development without contradiction of strict privacy policies of confidential conversations about mental health.

4.6.4 Data Collection Sequence

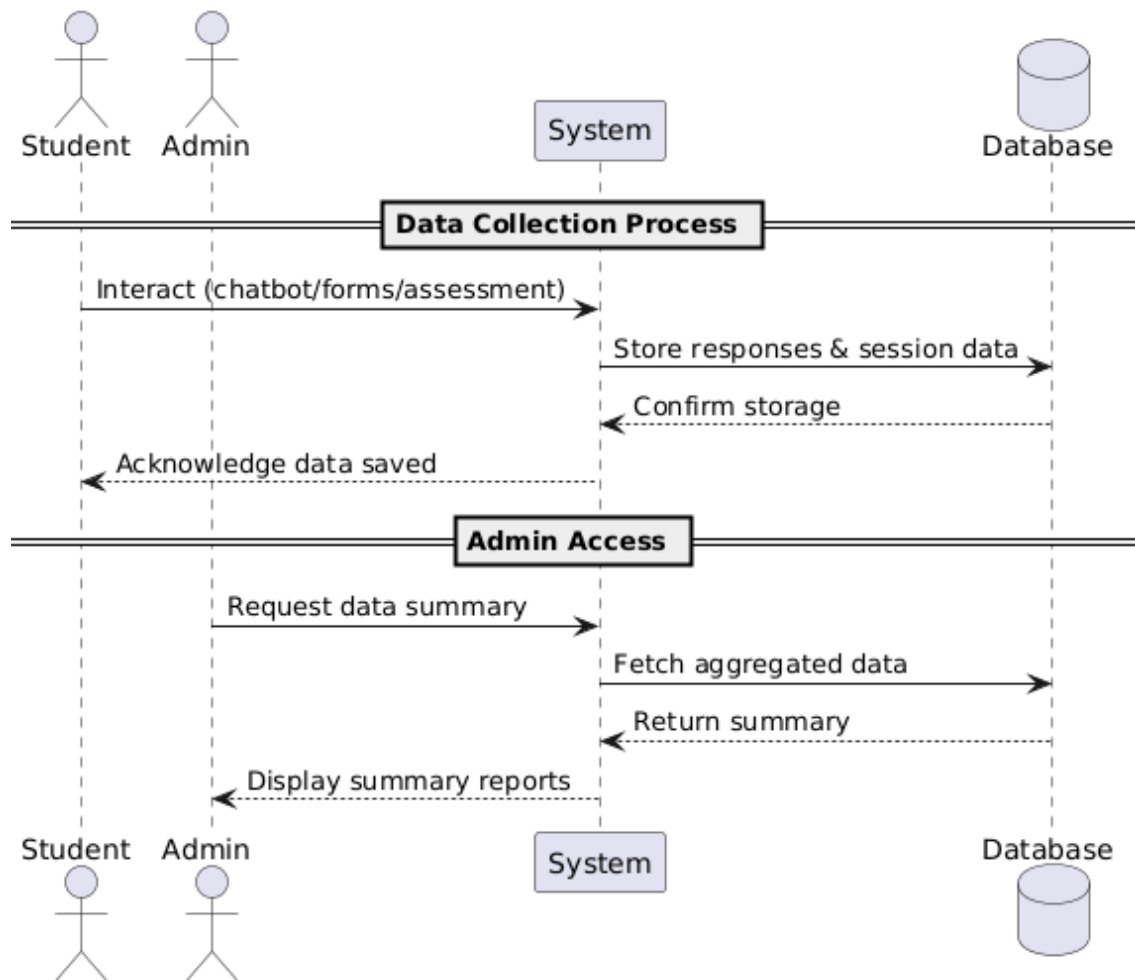


Figure 4.9: Data Collection Sequence Diagram

The data collection sequence demonstrates how the system gathers the information systematically across a wide variety of sources, including the responses of survey, chatbot, and user activity patterns. Such extensive data gathering allows training machine learning models and proposing individualised interventions. The system ensures that all information is stored securely and anonymously as per privacy laws and ethics of handling mental health information.

4.6.5 Doctor Recommendation Sequence

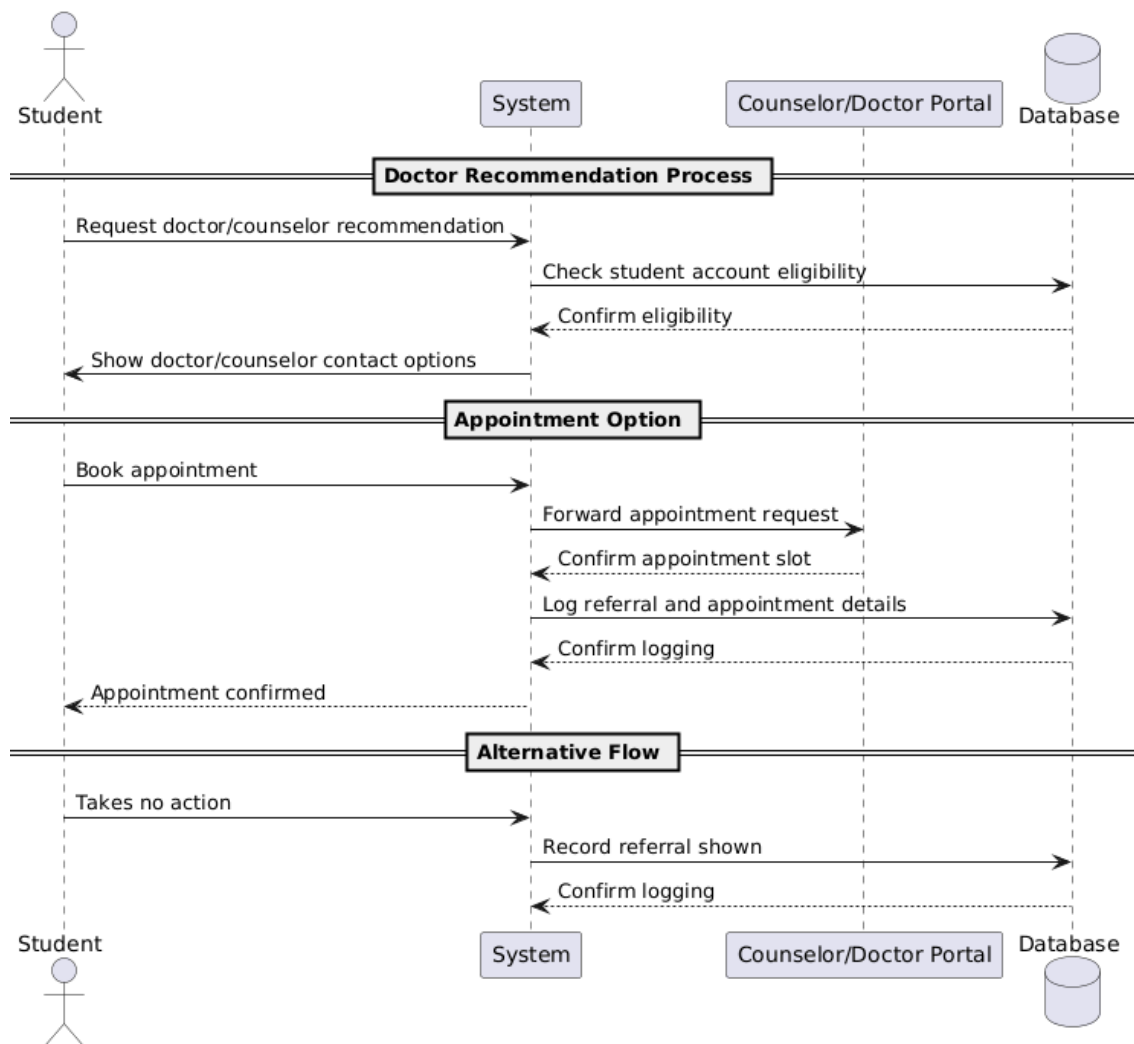


Figure 4.10: Doctor Recommendation Sequence Diagram

The doctor recommendation sequence proves the capability of the system to identify students who require professional mental health intervention and make scheduling appointments easier. The system proposes the most appropriate medical experts of the Well-Being Center of the university based on the results of the evaluation and communication with the chatbot. The integrated system of booking would allow students to do that directly, which ensures that they will easily access expert mental health help when needed.

4.6.6 Game Recommendation Sequence

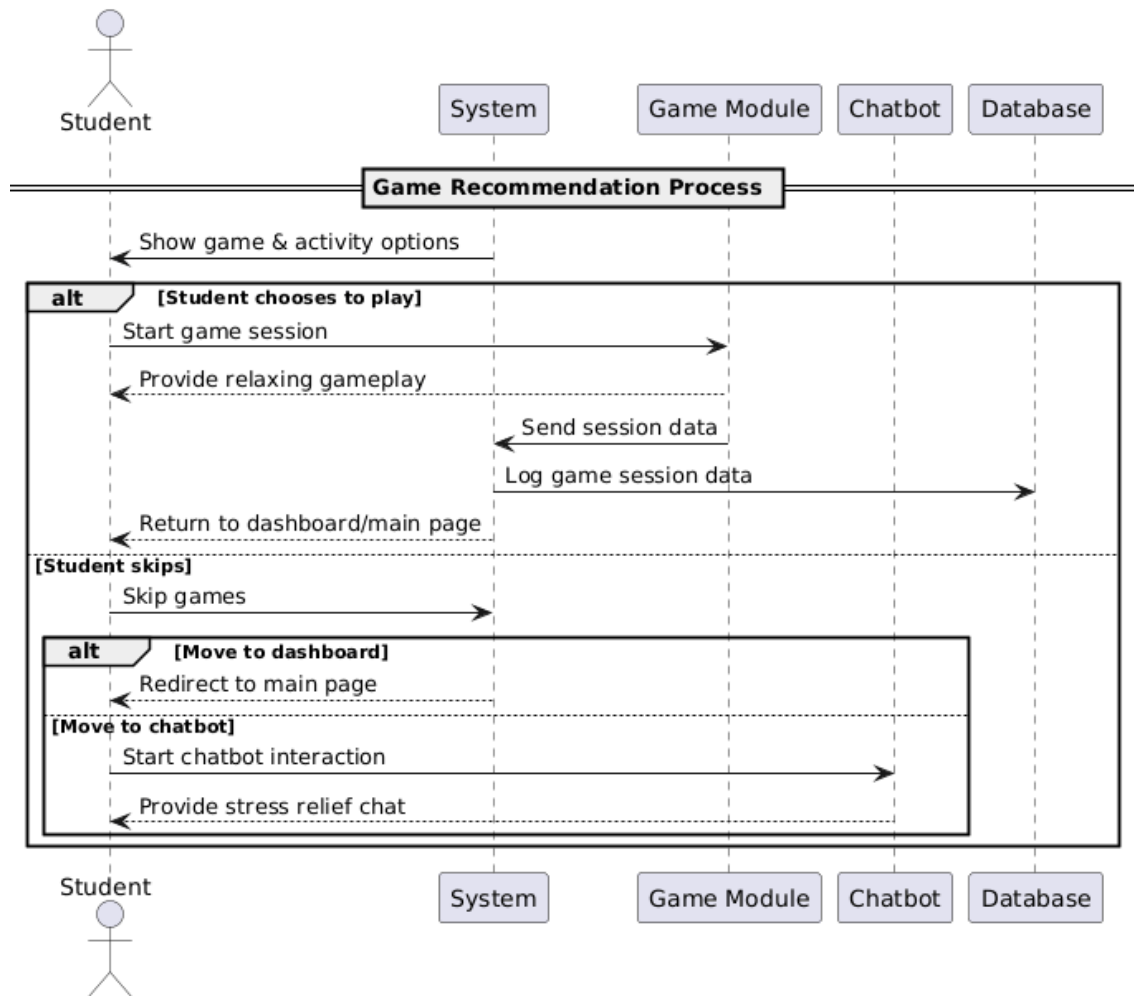


Figure 4.11: Stress-Relief Game Recommendation Sequence Diagram

The game recommendation sequence indicates how the system would recommend tailored stress- relievers according to an individual consideration of the mental health assessment. It gives students individualised game recommendations depending on the level of stress and what they require in the therapy. The system tracks the number of games played and the performance of the students and it uses the data to enhance future suggestions and monitor how the students are performing in terms of their stress management using interactive therapeutic based interventions.

4.6.7 Therapy Recommendation Process Sequence

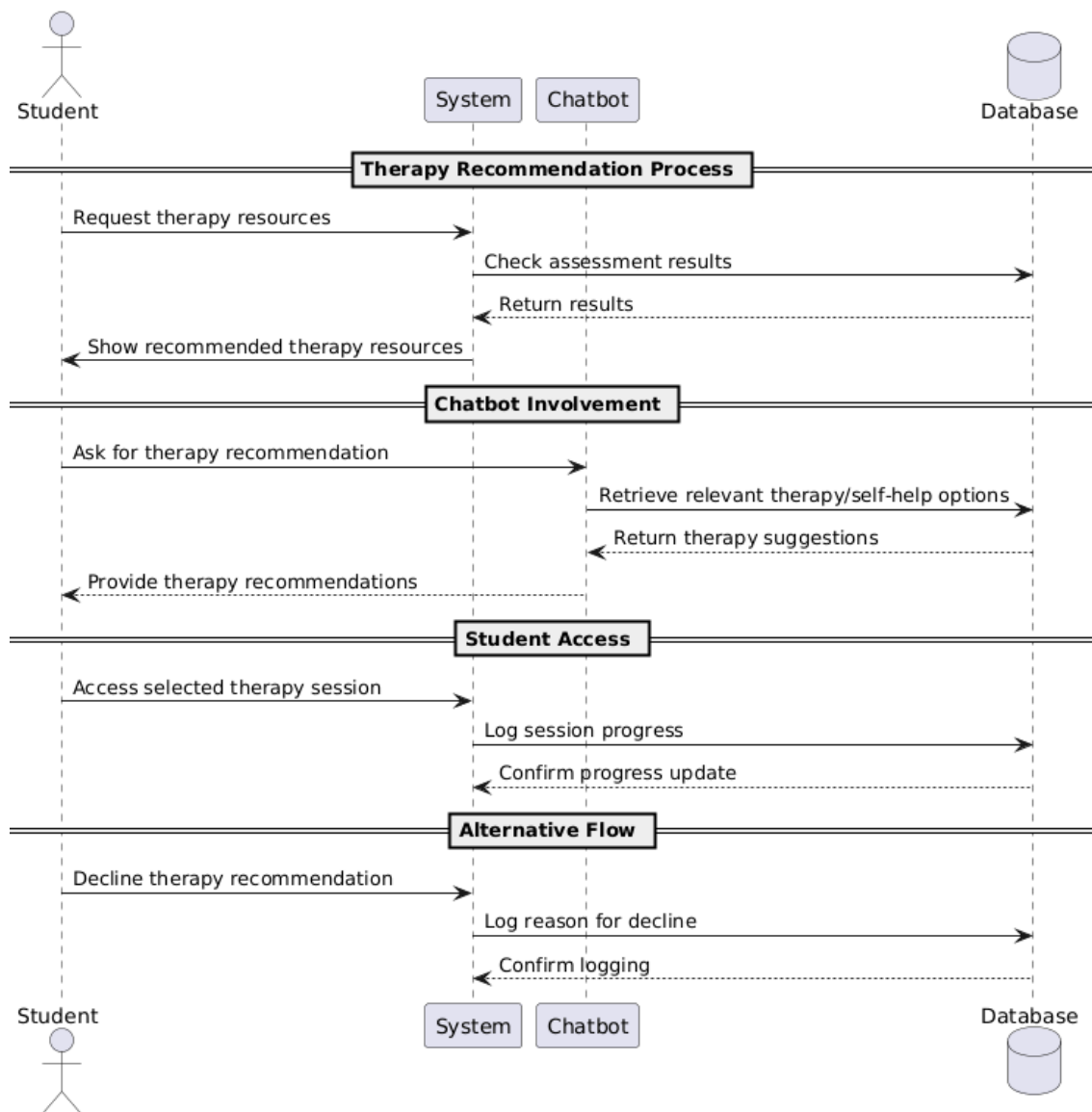


Figure 4.12: Therapy Recommendation Process Sequence Diagram

The therapy recommendation sequence demonstrates how to provide students with individualized therapeutic content and works in a comprehensive manner. The system examines the outcomes of the tests and the dialogues with the chatbot to provide the most appropriate self-help solutions, coping mechanisms, and therapy materials. Students have a choice of the therapy sessions, which they want to receive and the system tracks their progress and makes sure that changes take place to ensure that they receive continuous therapeutic support and interventions are effective.

4.6.8 Reassessment Sequence

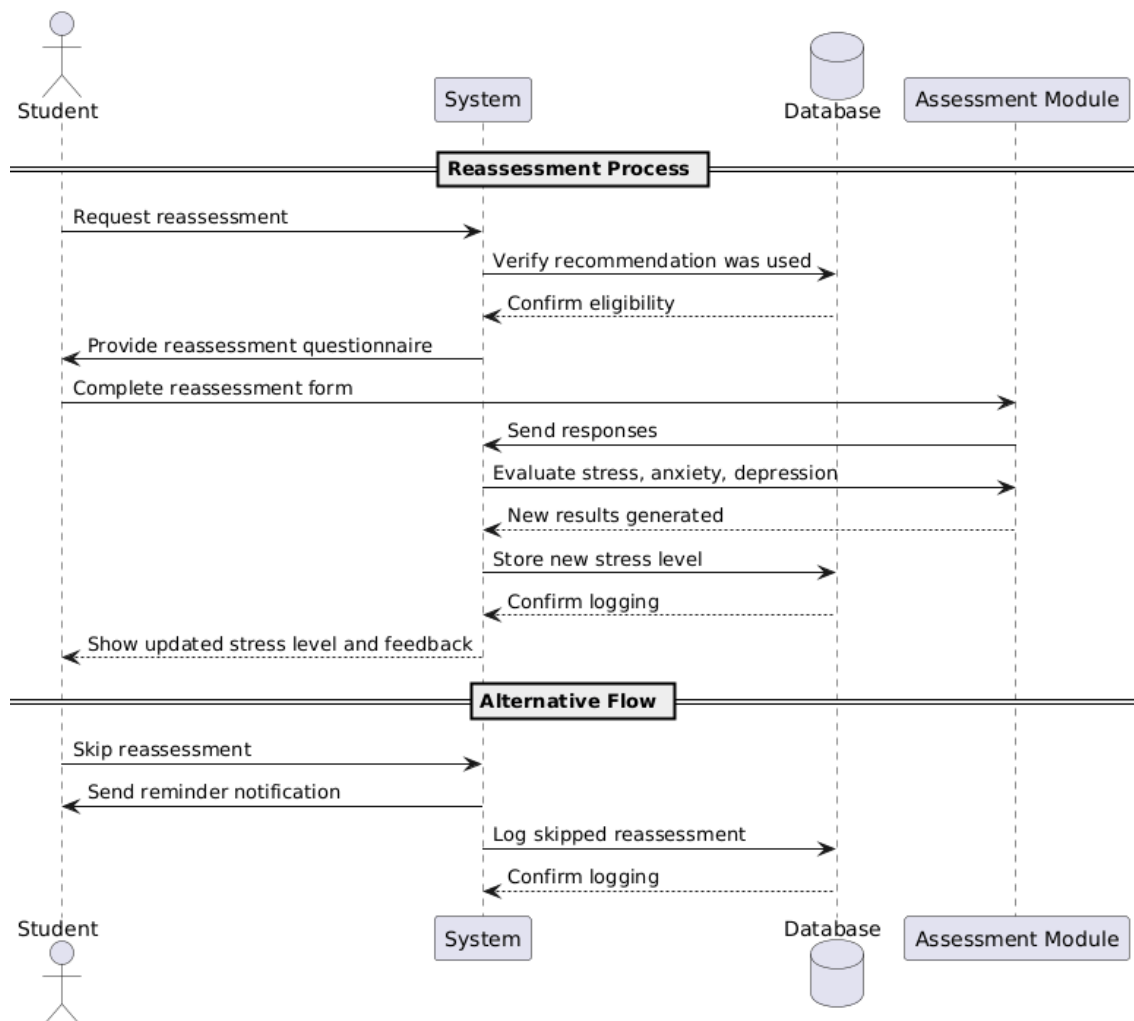


Figure 4.13: Mental Health Reassessment Sequence Diagram

The series of reassessments indicates the continuous monitoring strategy, where students have the option of retaking mental health tests after using system interventions. This process makes it possible to track the progress and understand where the additional assistance is necessary by comparing the new assessment scores with the previous ones. The system provides immediate feedback on the progress and alters the manner in which it aids depending on the change in the mental health of the individual.

4.6.9 Report Generation Sequence

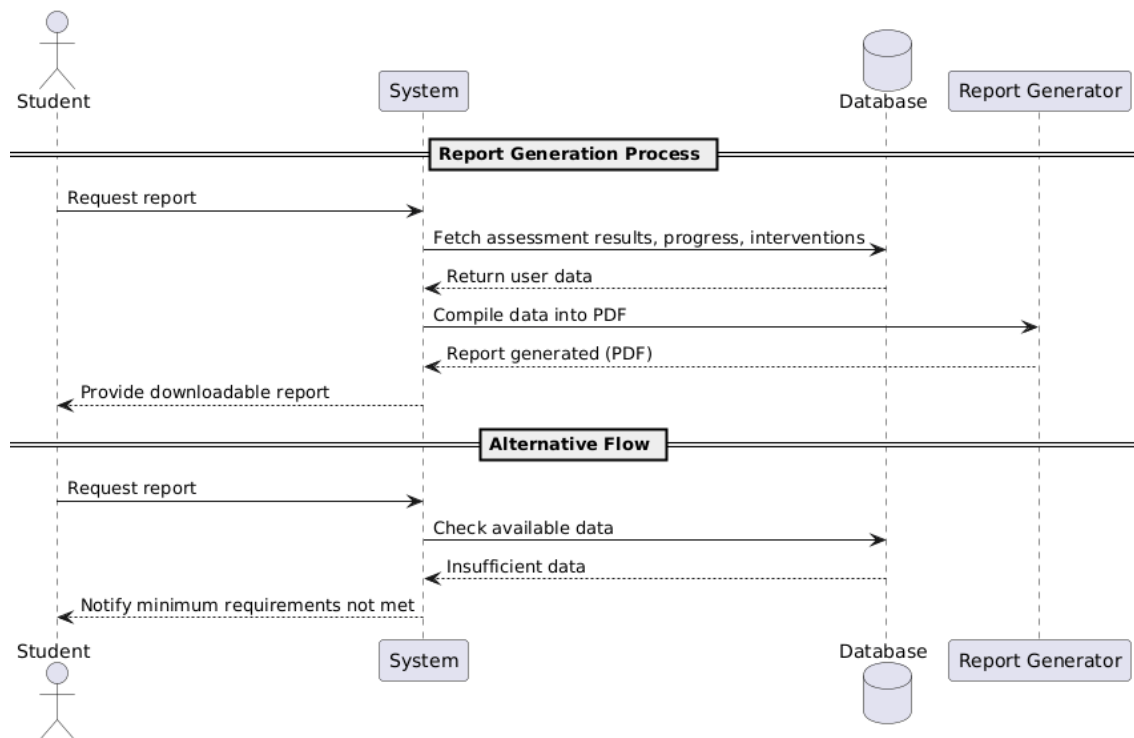


Figure 4.14: Report Generation Sequence Diagram

The flow of report generation demonstrates the manner in which the complete analytics and documentation process is executed so as to create detailed progress reports to the students and administrators of the Well-Being Center. The system combines the results of the assessment, the involvement in interventions, and the measures of progress and forms the PDFs that can be downloaded. Such reports allow students and professionals in healthcare to communicate with each other and provide valuable insights to enhance the system and assess the efficiency of mental health programs.

4.7 Low Level Design

The Low Level Design (LLD) provides a clear understanding of the way the AI-Based Student Stress Management System is configured and how the data is organized. In this section, one discusses the schema design of a database, entity relations and data flow patterns that can enable the system to handle mental health in a holistic manner.

4.7.1 Entity Relationship Diagrams

To ensure that the data is correct, eliminate redundancy, and allow efficient querying of the database to support the mental health analytics, the database structure will follow a

normalized relational model. The Entity Relationship Diagrams (ERD) below represent the database schema of all entities, attributes and relationships which form the foundation of the data architecture of the system.

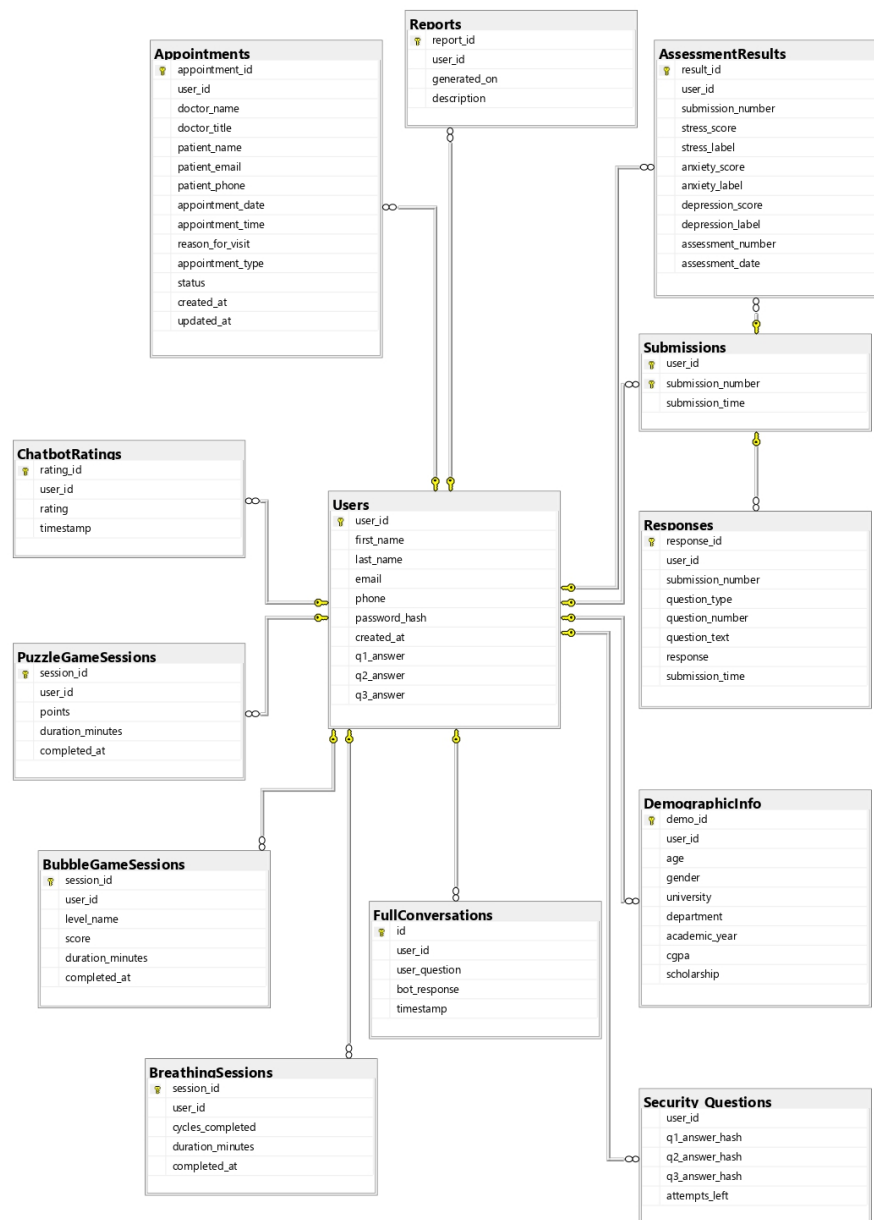


Figure 4.15: Main Entity Relationship Diagram - Core Database Schema

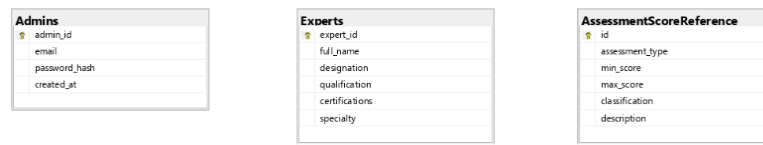


Figure 4.16: Extended Entity Relationship Diagram

The ERD diagrams shown in Figures 4.15 and 4.16 present the comprehensive database design encompassing all system functionalities. The primary schema consists of such entities as Users to authenticate users, assessment related (AssessmentResults, Submissions, Responses) to conduct mental health tests, and special modules to communicate with a chatbot, therapeutic activities and appointments. The long schema will include Admins, Experts, and AssessmentScoreReference in order to manage the system and to evaluate it on a standardized basis. The relations are referentially intact, support complex queries, and allow customized recommendations, tracking progress, and mental health analytics, which will guarantee effective data management in support of AI-driven support of students.

4.8 GUI Design

The AI-Based Student Stress Management System with its Graphical User Interface (GUI) is designed to focus on the user-centered design principles, which makes it accessible and easy to navigate and easy to use. The interface design is based on the current web design principles that include responsive layouts, proper visual hierarchy, and uniform design patterns in all the modules of the system. The GUI implementation offers easy interaction channels among the students and the administrators as well as being professional enough to be used in mental health.

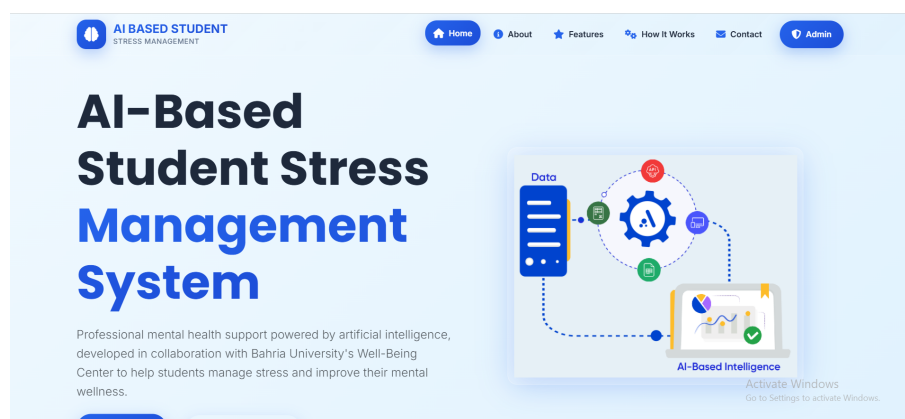


Figure 4.17: Landing Page Interface

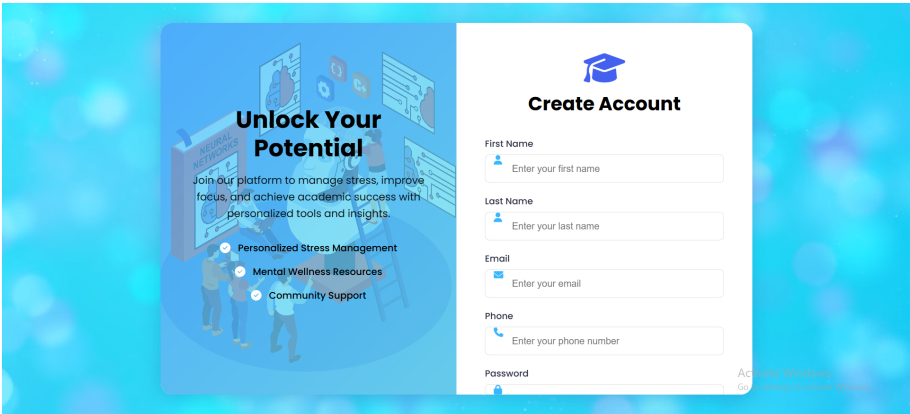


Figure 4.18: User Registration Interface

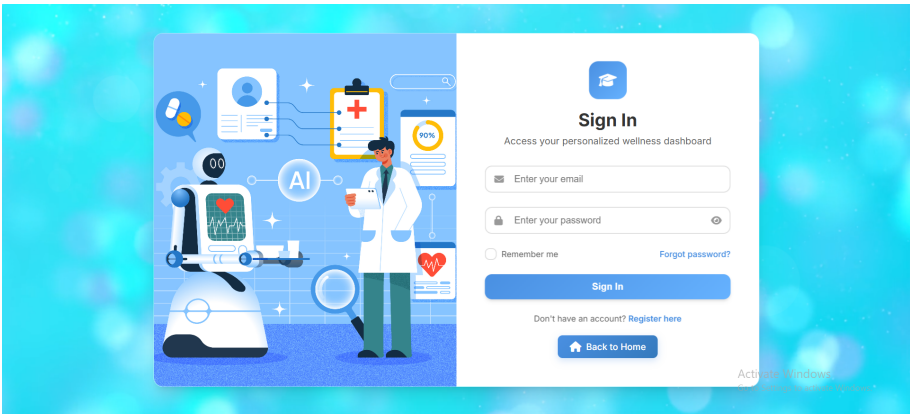


Figure 4.19: Student Login Interface

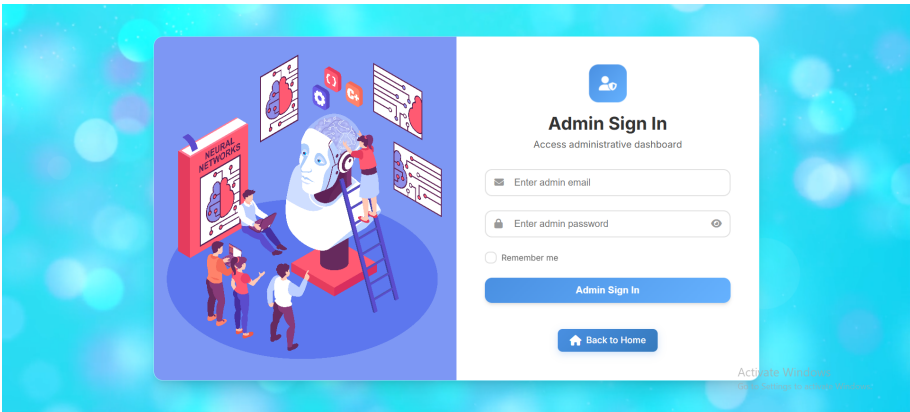


Figure 4.20: Administrative Login Interface

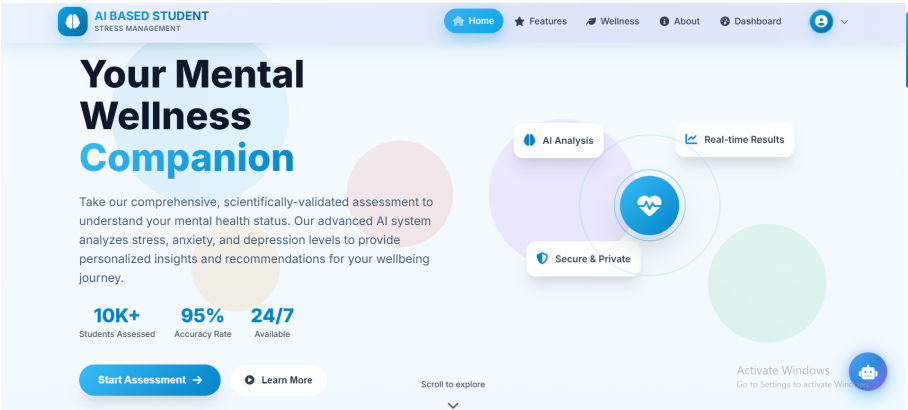


Figure 4.21: Main Page Interface

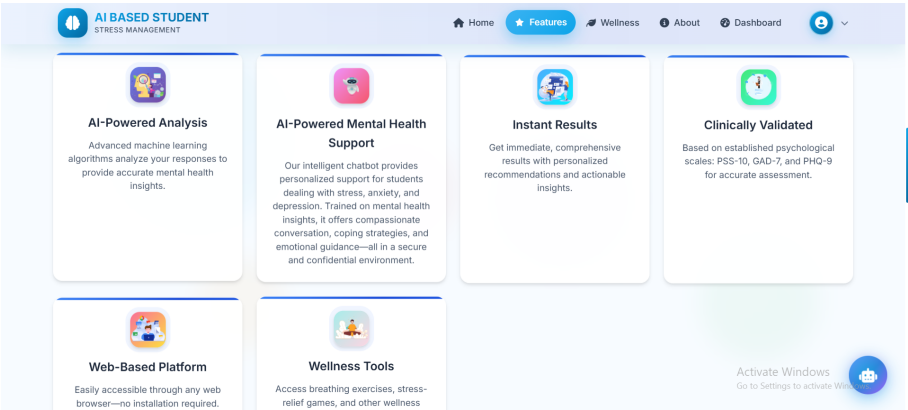


Figure 4.22: System Features Interface

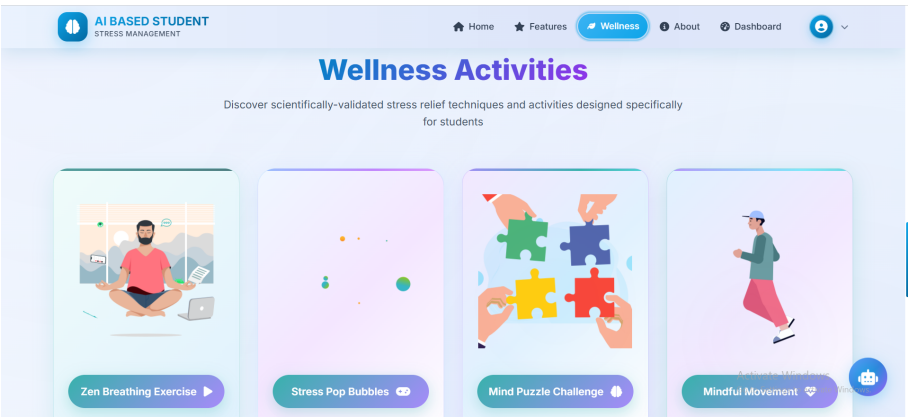


Figure 4.23: Wellness Activities Interface

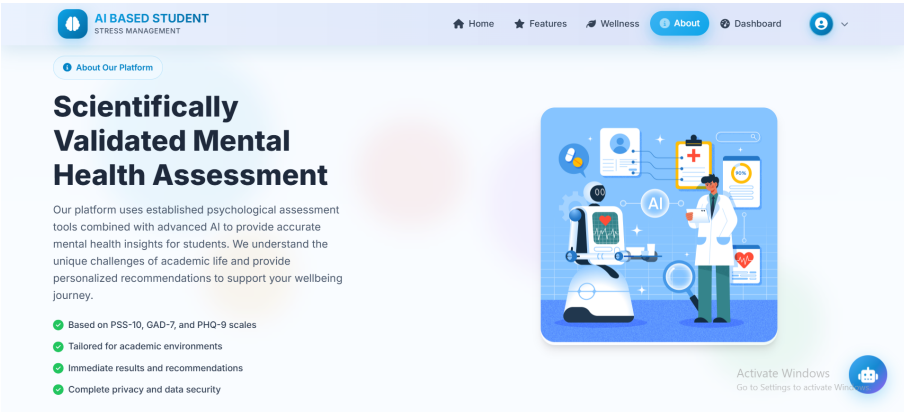


Figure 4.24: About Page Interface

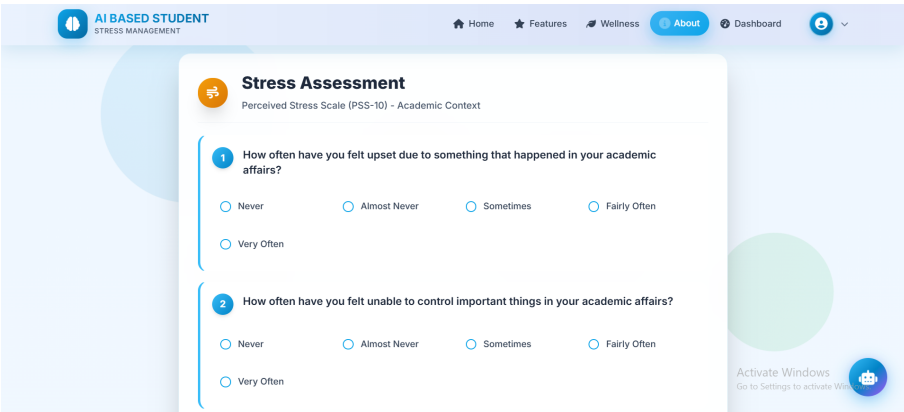


Figure 4.25: Stress Assessment Interface

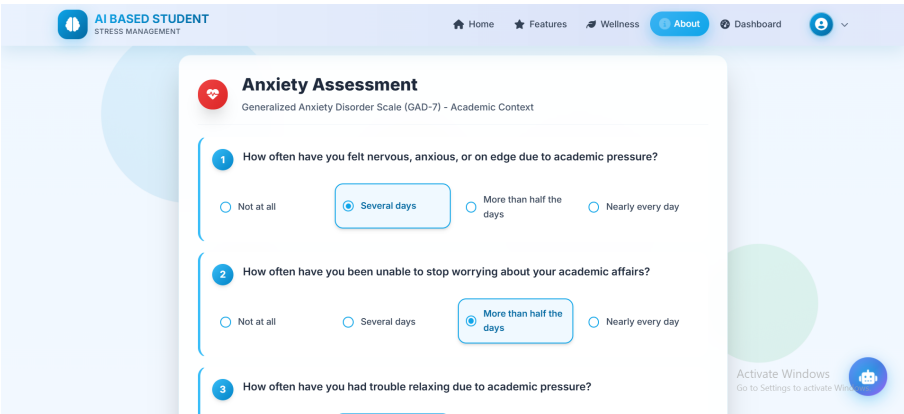


Figure 4.26: Anxiety Assessment Interface

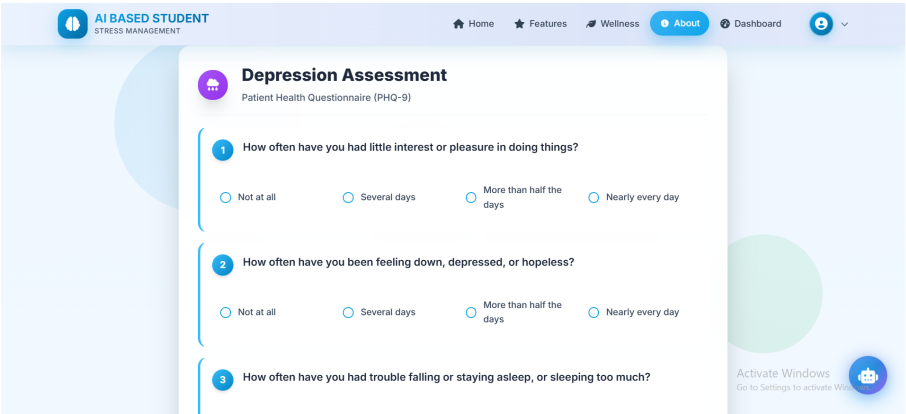


Figure 4.27: Depression Assessment Interface

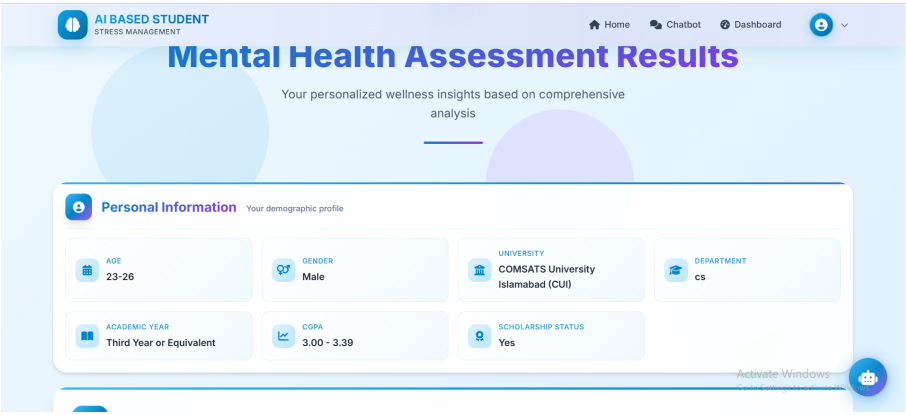


Figure 4.28: Results

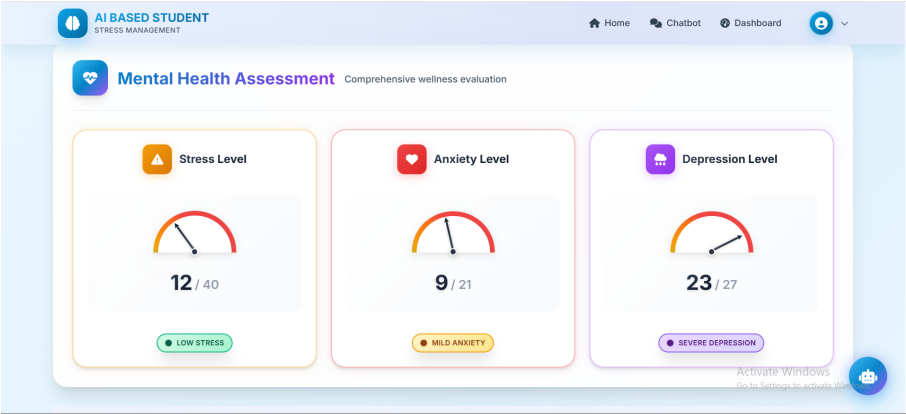


Figure 4.29: Results(continued)

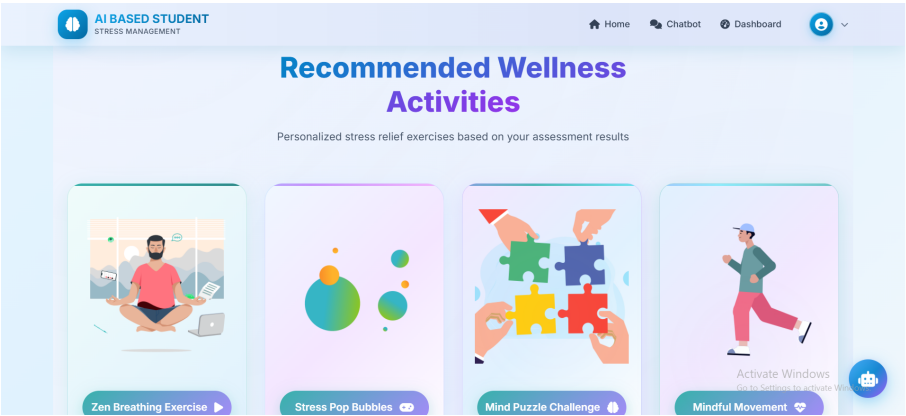


Figure 4.30: Recommended games

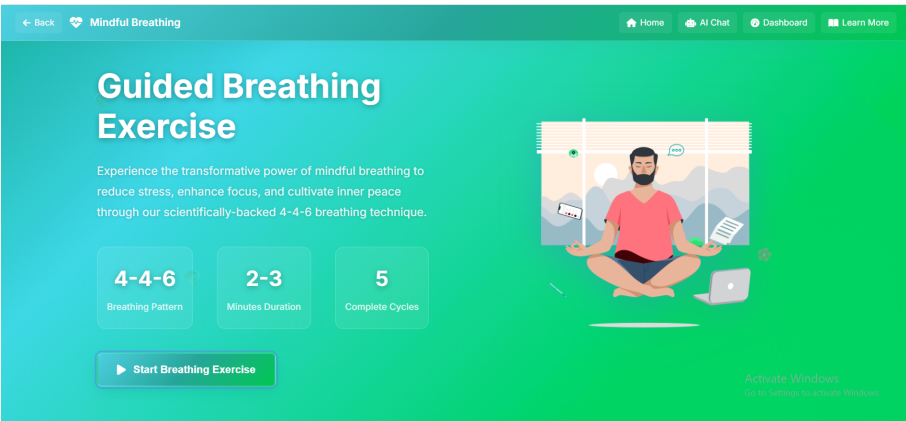


Figure 4.31: Breathing Exercise Interface - Setup

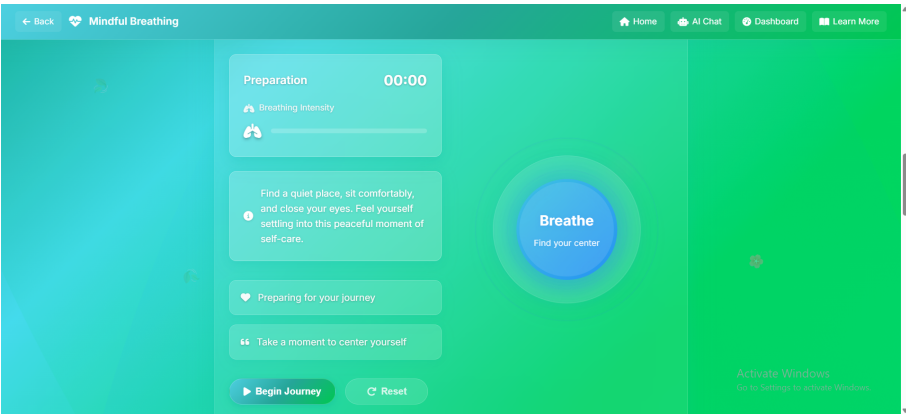


Figure 4.32: Breathing Exercise Interface - Active Session

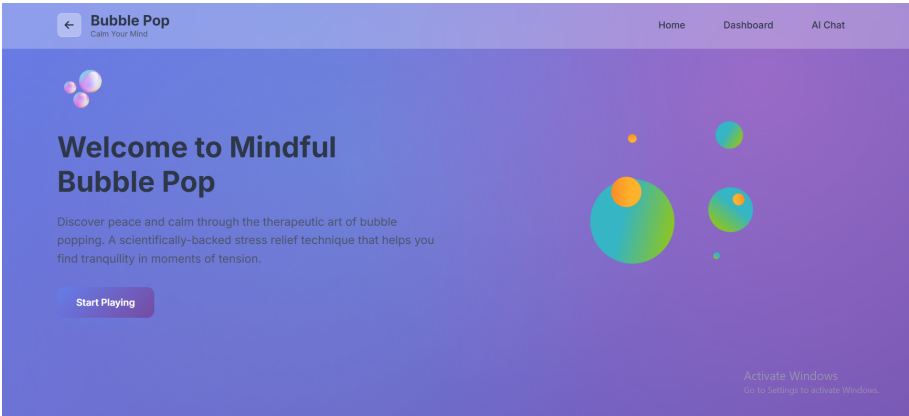


Figure 4.33: Bubble Pop Game Interface - Main Menu

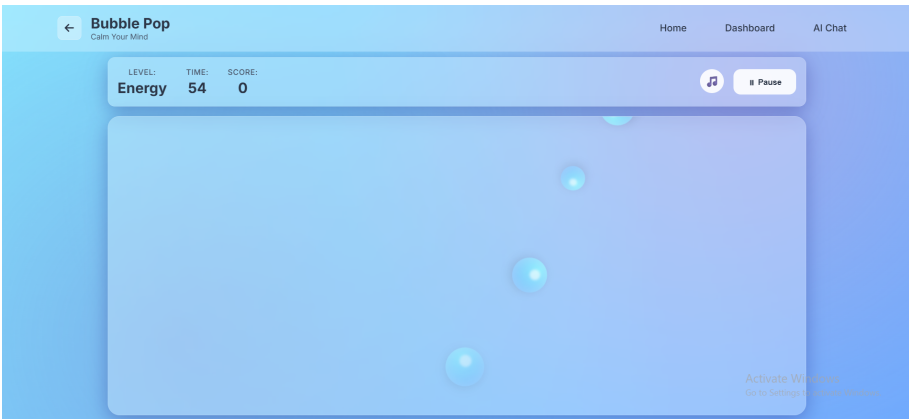


Figure 4.34: Bubble Pop Game Interface - Active Gameplay

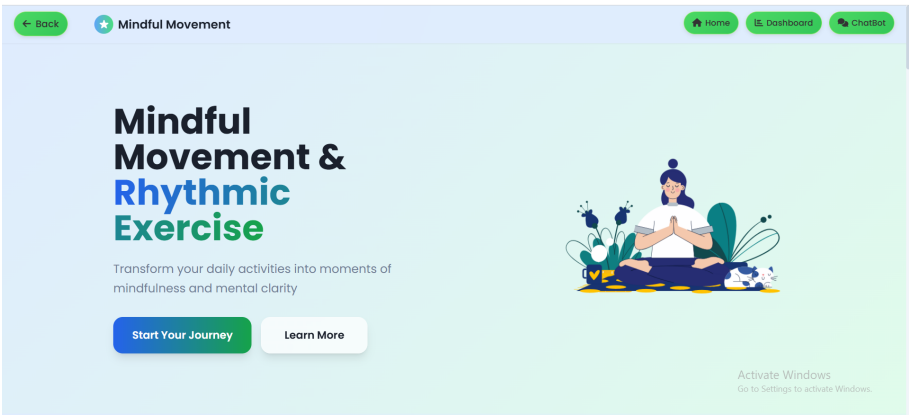


Figure 4.35: Mindful Activities Interface - Primary

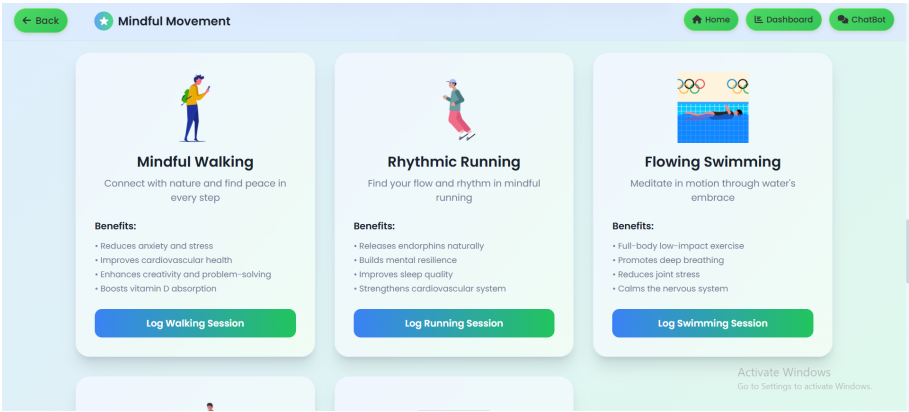


Figure 4.36: Mindful Activities Interface - Secondary

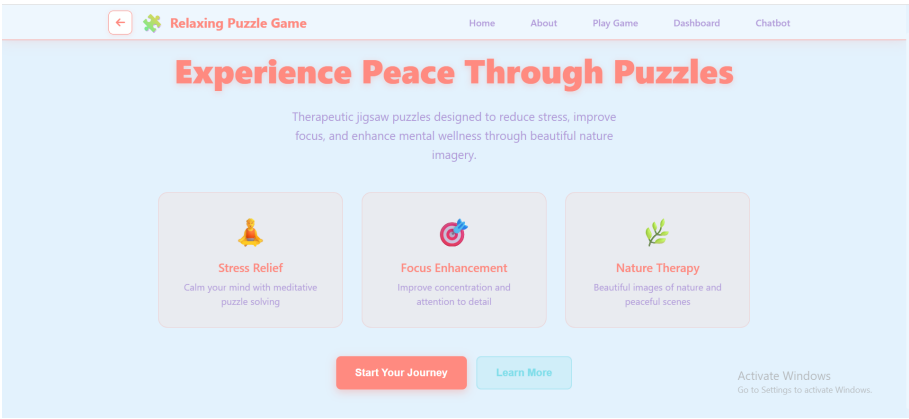


Figure 4.37: Puzzle Activities Interface - Primary

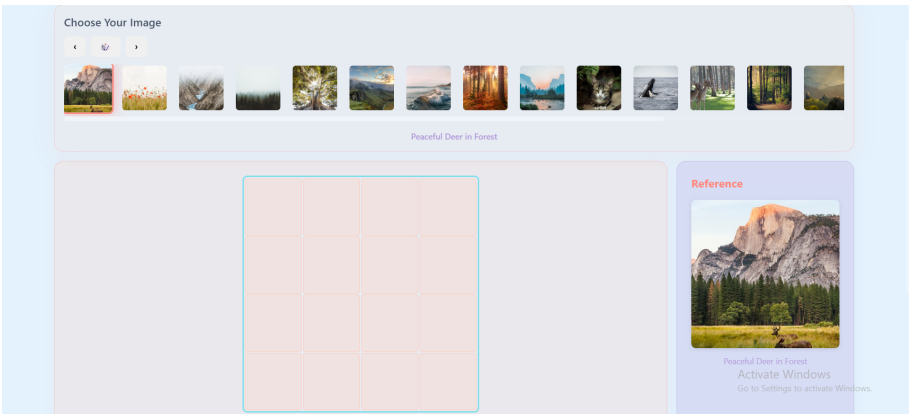


Figure 4.38: Puzzle Activities Interface - Secondary

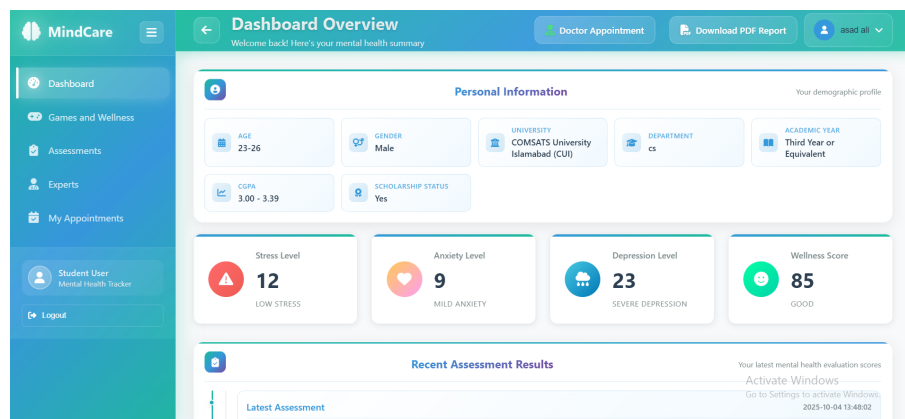


Figure 4.39: User Dashboard Interface

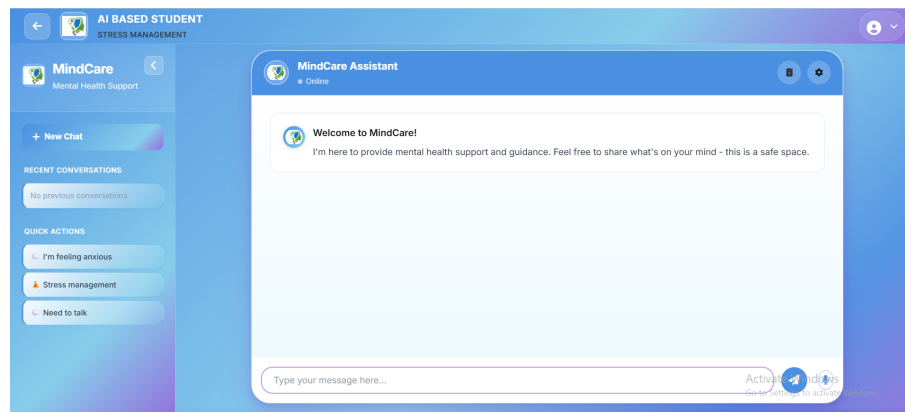


Figure 4.40: Chatbot Interface



Figure 4.41: Doctor's Appointment Interface

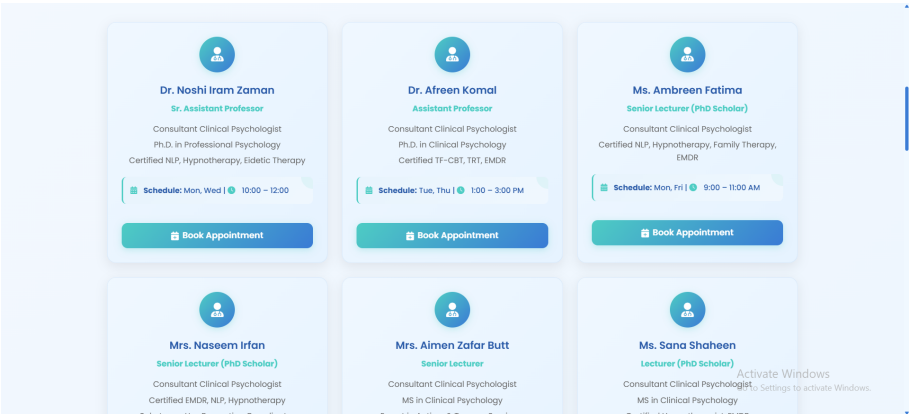


Figure 4.42: Doctor’s Appointment Booking Interface

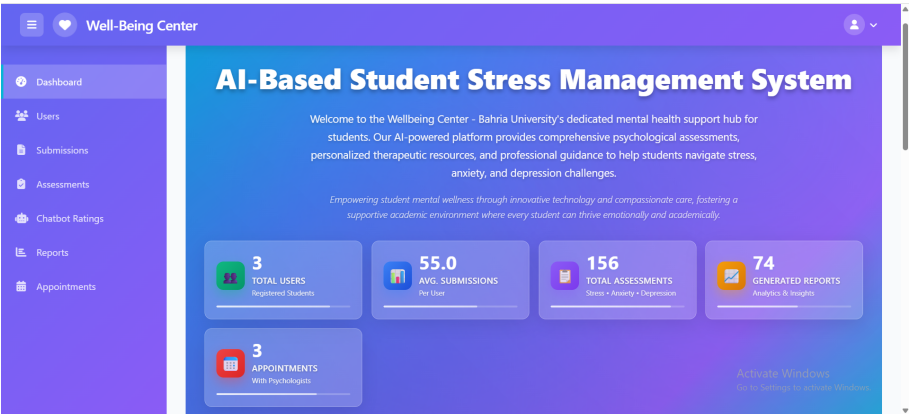


Figure 4.43: Admin Dashboard Interface

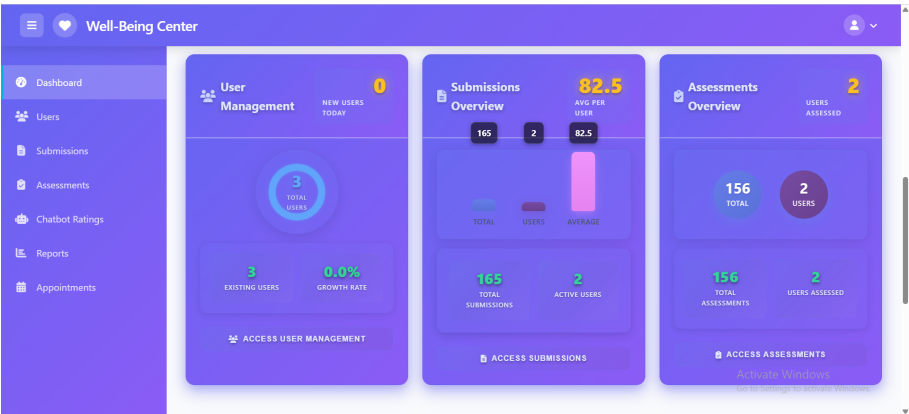


Figure 4.44: Admin Dashboard 2 Interface

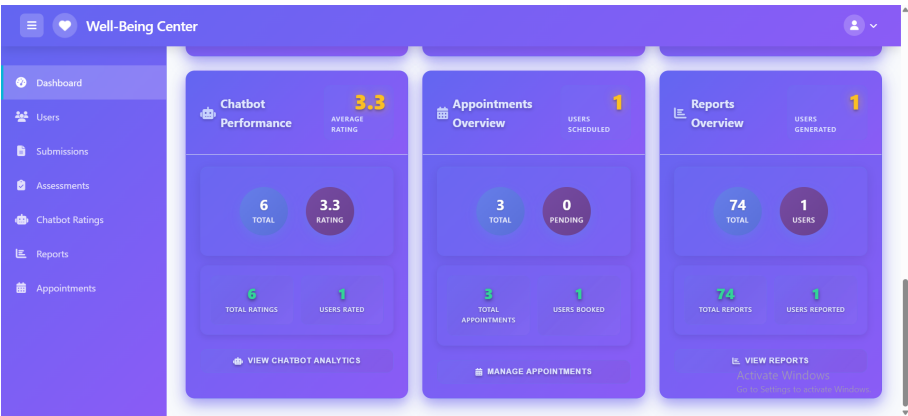


Figure 4.45: Admin Dashboard 3 Interface

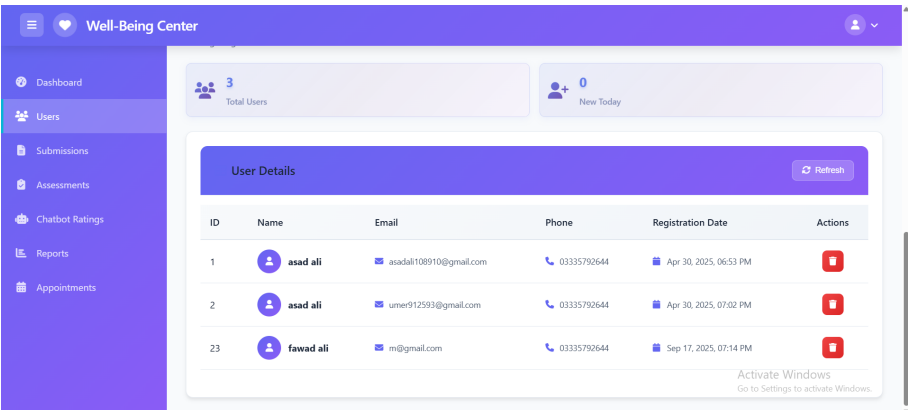


Figure 4.46: Users Interface

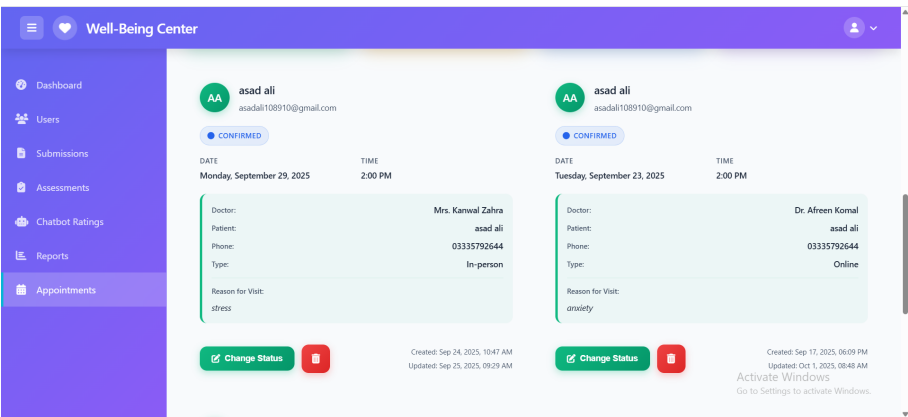


Figure 4.47: Appointments Interface

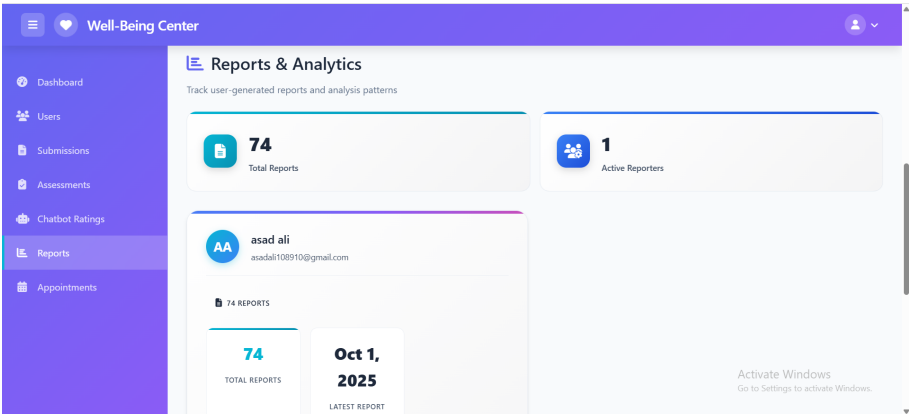


Figure 4.48: Reports Interface

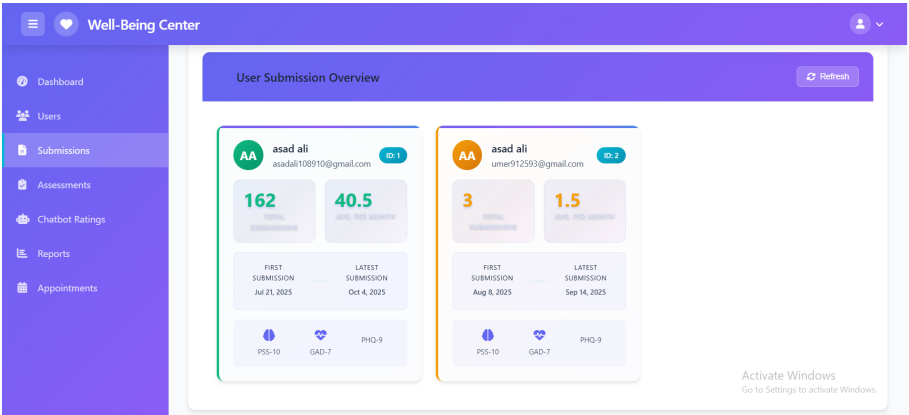


Figure 4.49: Submissions Interface

Chapter 5

System Implementation

Implementation is the process of converting an idea into reality. System implementation is the execution of a technical specification or an algorithm in the form of a program, a software component or otherwise a computer system, through programming and implementation.

5.1 System Architecture

The AI-Based Student Stress Management System is in a 4-Tier Architecture that aims to offer scalable, maintainable, and efficient mental health support services. Such an architectural design will give a clear separation of concerns, which allows easy maintenance, updates, and further improvements of the system without compromising its optimum performance and security.

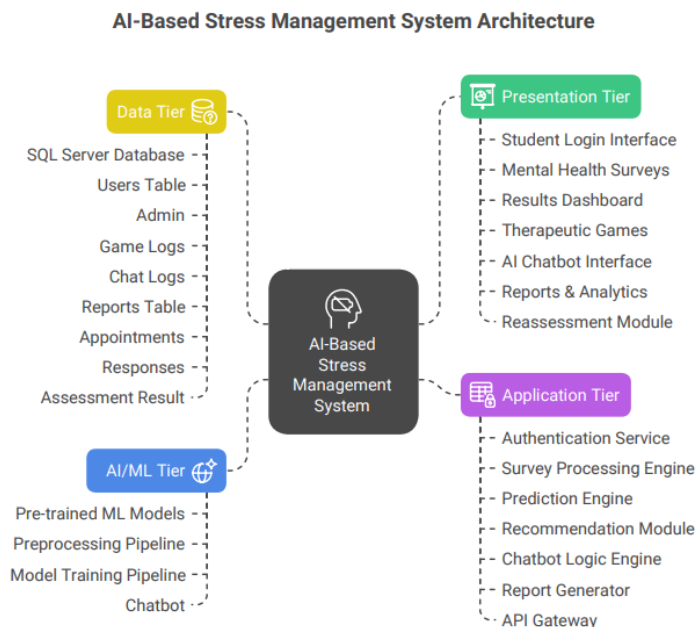


Figure 5.1: AI-Based Student Stress Management System Architecture

The architectural diagram shown in Figure 5.1 shows the entire 4-level framework around which the AI-Based Student Stress Management System is built. All levels have their purpose and integrate well with other layers to provide a unified mental health support platform.

5.1.1 Presentation Tier - User Interface Layer

The Presentation Tier is the most important interface that students and administrators use the system. This layer is developed based on current web tools such as HTML5, CSS3, and JavaScript so that cross-browsing and responsive web development on the desktop and mobile platforms are facilitated.

5.1.1.1 Student Interface Components:

- **Student Login Interface:** Authentication service and access to personal mental health dashboard by students.
- **Mental Health Surveys:** PSS-10, GAD-7 and PHQ-9 standardized psychological assessment scales were used as interactive forms.
- **Results Dashboard:** Detailed presentation of the results of assessment in the form of visualization of stress, anxiety and depression levels.
- **Therapeutic Games:** Availability of stress relieving activities such as breathing exercises, bubble pop games, puzzle challenges and mindful moving activities.
- **AI Chatbot Interface:** Live chat support system with 24/7 mental health support and coping skills.
- **Doctor Appointments:** Combined appointment booking platform allowing students to make appointments with professionals of Bahria University Well-Being Center.
- **Reports and Analytics:** Individual monitoring of progress and the ability to download report in PDF format depicting a history of assessments and intervention efficacy.
- **Reassessment Module:** Follow-up evaluation system in which students can monitor their mental health improvements with time.

5.1.1.2 Administrative Interface Components:

- **Admin Dashboard:** General description of system usage, student interaction rates, and student mental health patterns.
- **User Management:** Student monitoring tools and user account management tools.

- **Appointment Management:** Personnel scheduling and coordination systems Well-Being Center.
- **System Analytics:** System optimization performance monitoring and reporting.
- **Reports Overview:** Administrative access to access, analyze and control all that is generated in student reports such as assessment summary, progress tracking and intervention effect documentation.
- **Submissions Management:** It has ability to monitor and review all submissions of student assessment like PSS-10, GAD-7 and PHQ-9 with a tracking record of time and completion.
- **Assessments Overview:** Monitoring the rates of assessment participation, scores distribution, and tendencies of mental health classification in the student population.
- **Chatbot Management:** mange the chatbot see the rating of chatbot.

5.1.2 Application Tier - Business Logic Layer

Application Tier contains the business logic and is the point where all the operations of the system are coordinated. Built on the Flask framework, this tier ensures efficient communication between the user interface and underlying data systems.

5.1.2.1 Core Application Modules:

- **Authentication Service:** Implements secure user registration, login, and session management using Werkzeug Security for password hashing and protection against unauthorized access
- **Survey Processing Engine:** Handles the administration and scoring of psychological assessments, ensuring accurate calculation of PSS-10, GAD-7, and PHQ-9 scores according to established clinical guidelines
- **Prediction Engine:** Coordinates with the AI/ML Tier to process assessment responses and generate accurate mental health classifications and severity predictions
- **Recommendation Module:** Generates personalized intervention suggestions including appropriate therapeutic games, coping strategies, and professional referrals based on individual assessment results
- **Chatbot Logic Engine:** Manages conversational AI interactions, processes natural language queries, and provides evidence-based mental health support using DSM-5 aligned responses

- **Report Generator:** Creates comprehensive analytics reports for both students and administrators, compiling assessment results, intervention participation, and progress metrics
- **API Gateway:** Facilitates secure communication between different system components and external services while maintaining data integrity and system security
- **Doctor Appointment Module:** Manages professional consultation scheduling, availability tracking, and appointment confirmation systems for Well-Being Center integration

5.1.3 Data Tier - Information Storage Layer

The Data Tier offers effective and secure data storage with SQL Server Database and data consistency, integrity, and availability to all the system operations. This layer handles the entire life cycle of the mental health data without compromising the privacy and security requirements.

5.1.3.1 Database Components:

- **Users Table:** Database that captures the student registration details, authentication details and the profile data using anonymized identifiers to guard against privacy breaches.
- **Survey Responses:** The complete storage of the assessment questionnaire responses of PSS, GAD-7, and PHQ-9 with time stamps to longitudinal analysis.
- **Assessment Results:** Mental health classification, severity, and prediction output that has been produced by models of machine learning.
- **GameLogs:** Stress-relief intervention monitoring with such indicators as participation rates, session length and effectiveness ratings.
- **ChatLogs:** History of chats and AI-interaction that can be continuously used to improve chatbot response and preserve user confidentiality.
- **Reports Database:** Created analytics and progress reports to the individual student and administrative management.
- **Appointments:** Professional consultation scheduling records, availability records and appointment management records.
- **Admin Tables:** System configuration and employee administration data of Well-Being Center staff.

5.1.4 AI/ML Tier - Intelligence and Analysis Layer

The AI/ML Tier takes into consideration advanced artificial intelligence and machine learning features to offer intelligent mental health analysis, custom recommendations and intelligent support systems. This layer utilizes specific processing facilities in order to provide optimum performance and precision.

5.1.4.1 Machine Learning Components:

- **Model for Stress Prediction:** With a set of 98 accuracy requirements, the specialized logistic regression algorithms being trained on PSS-10 data are then used to categorize levels of stress as Low (0-13), Moderate (14-26), and High (27-40) using supervised machine learning classification techniques.
- **Model of Anxiety Assessment:** Logistic regression classification system using binary classification methods and clinical thresholds that is based on the GAD-7 and classifies levels of anxiety as minimal (0-4), moderate (5-11) to severe (12-21).
- **Depression Analysis Model:** PHQ-9 combined logistic regression model: The PHQ-9 combined logistic regression model based on the existing diagnostic criteria with a multi-classification capacity can be used to classify depression as No Depression (0) to Severe Depression (20-27).
- **Preprocessing Pipeline:** Feature engineering tools included (scalers and encoders) and data cleaning and normalization are useful in preprocessing the pipeline to maximize model performance.
- **Model Training Pipeline:** Given anonymized data of student respondents, this is a model training pipeline that ensures privacy standards and enhances prediction accuracy as a continuous learning system.

5.1.4.2 AI Support Systems:

- **LLM-LLaMA 3.1 8B API:** The combination of large language models makes possible more advanced chatbot features with natural language processing of complex mental health conversations.
- **Quadrant API:** A high-technology data classification and pattern recognition system used to establish the efficiency of interventions and trends in mental health.

The 4-tier architecture offers an overall confidence that the AI-Based Student Stress Management System is trustworthy, flexible and smart in delivering mental health services and ensuring data security, user privacy and clinical performance up to the top achievable level. It is these interconnected levels that enable the free flow of the data, the dynamism

of the responses to the needs of the individual students, and real time processing to be effectively utilized as a framework to facilitate the entire range of mental health services at the university.

5.2 System Internal Components

The AI-Based Student Stress Management System has a number of interrelated inner parts that collaborate to provide an all-encompassing mental health support service. Every element in it has a designated functionality to achieve the best system functionality and user experience.

5.2.1 System Functionality Overview

System functionality is structured into several integrated modules resulting in a complete provision of a mental health management solution. The components will work in harmony with other elements of the 4-tier architecture to provide evidence-based, personalized mental health assistance to university students.

5.2.1.1 Core Functional Components

Authentication and User Management System Authentication and User Management System Authentication system offers secure access control with the support of industry standard security protocols. It provides user registration, verification of login, session management, and password recovery feature. The system deploys Werkzeug Security to hash passwords and ensures the privacy of its users by using anonymized identifiers.

Mental Health Assessment Engine This element provides and processes standardized psychological tests which encompass:

- **Perceived Stress Scale (PSS-10):** Assesses the world-perception of stress that is classified into Low (0-13) to High (27-40).
- **Generalized Anxiety Disorder Scale (GAD-7):** Ranges between minimal (0-4) and severe (15-21).
- **Patient Health Questionnaire (PHQ-9):** Measures the signs of depression with No Depression (0) to Severe Depression (20-27).

Predictive Machine Learning System The prediction system takes and processes assessment responses to generate accurate mental health classifications based on pre-trained machine learning models. In the case of clinical decision support, the system provides real-time confidence interval predictions and still maintains 98 accuracy requirements.

Customized Suggestion Engine This element generates individualized recommendations of intervention by analyzing the results of the evaluation and interpersonal interaction characteristics, including:

- Right therapeutic games/stress-reducing exercises.
- Coping and relaxation methods based on evidence.
- Referral to specialists of the Bahria University Well-Being Center.
- Individual mental health sources and instructional resources.

AI Chatbot Support System The conversational AI will provide 24-hour mental health assistance based on the use of natural language processing. The chatbot that has been trained based on DSM-5 guidelines and the psychological best practices it offers:

- Short-term effective emotional care and crisis management.
- Mindfulness and led relaxation exercises, and stress reduction.
- referrals to professional mental health services.
- Learning throughout the interaction of the user and preserving privacy of the user.

Interactive Therapeutic Games Module This chapter provides evidence-based methods of reducing stress, which are expected to positively influence mental health:

- **Breathing Exercises:** Breathing exercises can be used to relieve stress.
- **Bubble Pop Games:** Participation in fun activities to decrease anxiety and increase mood.
- **Puzzle Challenges:** Engaging stress management tools
- **Mindful Movement Activities:** mind-capturing activities that promote mental health.

Professional Appointment Management System This factor simplifies the process of merging the services of the Bahria University Well-Being Center:

- Real-time booking of appointments with specialists
- Automated verification
- Secure communication between students and the medical professionals
- Integration with healthcare management system in the bahria university

Comprehensive Reporting and Analytics Module The reporting system generates overall analytics of students and administrators:

- Personal advancement graphs.
- Mental health long term trend study.
- Intervention effectiveness measures.
- Clinical records in PDF form (downloadable reports).
- Administrative dashboard having systemwide mental health measurements.

Data Security and Privacy Management System This is an important element that facilitates adherence to mental health data protection requirements:

- All communications between end points with sensitive data are encrypted.
- No personal identifiable information, anonymized data storage.
- Access control and audit logging of the database.

5.2.1.2 System Integration and Communication Protocols

The internal components can interact with each other via a strong API Gateway, which controls:

- Find-secure inter-communication protocols.
- Real time data synchronization within all the system modules.
- Load balancing to achieve optimum performance of the system.
- Error recovery and error management.
- Scalable architecture with support to multitasking users.

This end-to-end system design will make all these components collaborate to deliver reliable, user-friendly, clinically efficient mental health support services with the utmost standards of security, privacy, and performance.

5.3 Tools and Technologies

The AI-Based Student Stress Management System presents an interface of development tools, frameworks, and technologies as a combination to guarantee an efficient performance, reliability, and scalability.

Table 5.1: Tools and Technologies Used

Category	Tool/Technology	Purpose
Development Environment	Visual Studio Code	Code development and debugging for Python Flask application
Framework	Flask	Backend web framework for API and logic implementation
Frontend	HTML, CSS, JavaScript	Designing user interface and web layout
Database	Microsoft SQL Server	Data storage and management for user and assessment data
Design Tool	Figma	User interface and experience design
Machine Learning Library	Scikit-learn	Model training and prediction for stress, anxiety, and depression levels
Classification Algorithm	Logistic Regression	Assessment classification for predicting mental health conditions based on input data
Data Processing	Pandas, NumPy	Data cleaning, manipulation, and analysis
Vector Database	Qdrant Vector Store	Semantic search and context retrieval for intelligent chatbot responses
AI/Chatbot Model	LLaMA 3.1 (via Groq API)	Natural language processing for conversational mental health assistance
Documentation Platform	Overleaf	Report writing and LaTeX document compilation

All the technologies help the system to deliver precise stress assessments, smart chatbot communications, and a convenient interface to execute mental health support efficiently.

Chapter 6

System Testing and Evaluation

The AI-Based Student Stress Management System testing phase is an important phase to make sure the system is reliable, accurate, and generally works in real-world contexts. The aim of this stage is to detect and fix any functional, logical or usability problems to ensure that every system component is functioning properly. Extensive testing was conducted in a number of modules, such as user interface, chatbot interactions, stress prediction model, database operations, and appointment scheduling features. The main aim of this step is to ensure that the system satisfies the requirements discussed in the design and development phases, gives the right predictions of the stress levels, and achieves a user-friendly experience and ensure that the system is ready to be deployed and be used in real time by students and psychologists at the Wellbeing Center, Bahria University.

6.1 Graphical User Interface Testing

The graphical user interface (GUI) testing is done to make sure that all visuals and user interactions are working properly in various situations. This testing confirms system workflows, form submission, navigation and error handling systems. It is also aimed at checking the responsiveness and predictability of layouts on different devices and screen sizes. In addition, GUI testing ensures the visual consistency, color consistency, font consistency and general usability to ensure the user experience is smooth and user-friendly. Through thorough GUI testing, the future design flaws, broken links or usability problems are solved early enough and the resultant interface is visually presentable, fully operative and accessible to any user.

6.1.1 User Registration Test Case

Table 6.1: Test Case 1 & 2 - User Registration and Error Handling

Module	User Registration
Test Case IDs	TC001 – Registration Functionality, TC002 – Error Handling
Use Case ID	UC-02
Testers	Asad Ali Khan, Sana Zia
Description	Validate that users can register successfully with valid details and that system handles invalid or duplicate entries gracefully.
Pre-Requisites	• System running and accessible • Database connection active • Registration page loaded
Environment	Windows 11, Chrome/Firefox/Edge, SQL Server, Flask Framework
Scenario	Test registration workflow, input validation, password hashing, and duplicate email handling.
Test Steps	1. Open registration page 2. Enter valid details and submit form 3. Verify data stored securely and redirect to login 4. Re-attempt registration with duplicate email and short password 5. Validate error messages and field preservation
Test Inputs	Valid: John Doe, john.doe@student.bahria.edu.pk, +923001234567, Password: securepass123, Security Answers: Karachi, Blue, Max. Invalid: Password = "123", Duplicate Email = existing@student.bahria.edu.pk.
Expected Results	• Valid registration stores user data and redirects to login • Password hashed using Werkzeug • Security answers encrypted • Duplicate email and short password trigger error messages • Form retains user input for correction
Actual Results	• Valid data inserted successfully, password hashed, and redirect achieved • Duplicate email and password errors displayed correctly • Form data preserved after validation errors
Status	Pass
Comments	Registration and validation work as expected with secure password hashing, proper error handling, and strong user feedback for invalid inputs.

6.1.2 User Login Test Case

Table 6.2: Test Case - User Login and Error Handling

Module Name	User Login
Test Case ID	TC003
Use Case ID	UC-01
Tester Names	Asad Ali Khan, Sana Zia
Test Description	To verify successful login for registered users and proper error handling for invalid credentials.
Pre-Requisites	System running and accessible, database connected, login page loaded, and user already registered.
Environment Information	Windows 11, Chrome/Firefox/Edge, SQL Server, Flask Application.
Test Scenario	Validate successful login with correct credentials and display of appropriate messages for invalid ones.
Test Steps	1. Navigate to login page. 2. Enter valid/invalid email and password. 3. Click "Login" button. 4. Verify response and redirection or error message.
Test Inputs	• Valid: Email – “john.doe@student.bahria.edu.pk”, Password – “securepass123” • Invalid: Email – “nonexistent@email.com”, Password – “wrong-password”
Expected Results	1. Valid credentials: Redirect to main dashboard, create secure session, apply security headers. 2. Invalid credentials: Show “Invalid email or password” message, stay on login page, no session created.
Actual Results	1. System authenticated valid users and redirected successfully. 2. Password verification and session handling worked correctly. 3. Invalid logins displayed proper error message without revealing sensitive info.
Status	Pass
Comments	Login functionality and error validation operate correctly with secure authentication, session management, and user feedback.

6.1.3 Admin Login Test Case

Table 6.3: Test Case - Admin Login and Validation

Module Name	Admin Login
Test Case ID	TC005
Use Case ID	UC-13
Tester Names	Asad Ali Khan, Sana Zia
Test Description	To verify secure admin authentication and proper access to the admin dashboard.
Pre-Requisites	Admin account exists, system running, database connected, and admin login page loaded.
Environment Information	Windows 11, Chrome/Firefox/Edge, SQL Server, Flask Application.
Test Scenario	Validate successful login with correct credentials and ensure access is restricted to authorized admins.
Test Steps	1. Navigate to admin login page. 2. Enter valid/invalid credentials. 3. Click “Login”. 4. Observe system response and access control.
Test Inputs	• Valid: Email – “admin@wellbeing.bahria.edu.pk”, Password – “admin123secure”. • Invalid: Email – “fakeadmin@bahria.edu.pk”, Password – “wrong-pass”.
Expected Results	1. Valid login: Query Admins table, verify password, clear previous session, set session with role=‘admin’, redirect to dashboard. 2. Invalid login: Display “Invalid email or password”, stay on login page, no session created.
Actual Results	1. System correctly authenticated valid admin and redirected to dashboard. 2. Invalid credentials displayed proper error message without revealing sensitive info. 3. Session handling and role assignment worked securely.
Status	Pass
Comments	Admin login and validation function correctly. Secure authentication, session control, and role-based access are implemented as expected.

6.1.4 Assessment Form Submission Test Case

Table 6.4: Test Case 6 - Assessment Form Submission

Module	Assessment Form - Survey Completion
Test Case ID	TC006
Testers	Asad Ali Khan, Sana Zia
Description	Validate that users can complete and submit the assessment form with demographic data, stress (10Q), anxiety (7Q), and depression (9Q) scales.
Pre-Requisites	• User logged in • Database connection active • ML models loaded (stress, anxiety, depression) • Label encoders and scalers initialized • Form page accessible
Environment	Windows 11, Chrome/Firefox/Edge, SQL Server, Flask + Jinja2, Logistic Regression models
Scenario	Verify complete assessment workflow including demographic entry, questionnaire submission, ML predictions, and result storage.
Test Steps	1. Open assessment page after login 2. Fill demographic info (age, gender, university, etc.) 3. Complete all three scales (stress, anxiety, depression) 4. Submit the form 5. Validate demographic and response storage 6. Verify ML predictions and results storage 7. Confirm redirection to results page
Test Inputs	Age: 22, Gender: Male, University: Bahria University, Dept: CS, CGPA: 3.7, Scholarship: Merit-based. Stress: [3,2,4,1,3,2,4,3,2,1]; Anxiety: [2,3,1,4,2,3,2]; Depression: [1,2,3,2,1,4,2,3,1].
Expected Results	• Demographics inserted into database • Responses saved with submission ID • ML models predict correctly • Results stored and redirected to results page
Actual Results	• Data inserted and stored accurately • ML models and scalers processed data correctly • Session created and redirect successful
Status	Pass
Comments	Assessment submission works correctly; integrates ML predictions, ensures database integrity, and prevents duplicate submissions via PRG pattern.

6.1.5 Assessment Results Display Test Case

Table 6.5: Test Case 7 - Assessment Results Display

Module	Assessment Results Display
Test Case ID	TC007
Use Case ID	UC-03
Testers	Asad Ali Khan, Sana Zia
Description	Validate correct display of user results (stress, anxiety, depression) with demographics and session handling.
Pre-Requisites	• User logged in • Assessment completed • Results stored in session • Database connection active
Environment	Windows 11, Chrome/Firefox/Edge, SQL Server, Flask
Scenario	Verify session retrieval, data rendering, cache control, and redirect behavior.
Test Steps	1. Open results page 2. Retrieve session and user data 3. Display demographics and scores 4. Validate predictions and navigation info 5. Check cache headers and redirects
Session Data	User ID valid; Age 22, Male, Bahria University; Stress: 25 (Moderate), Anxiety: 14 (Mild), Depression: 18 (Low).
Database Data	John Doe, john.doe@student.bahria.edu.pk, Previous Assessment: Available.
Expected Results	Session and user data retrieved; results and demographics shown; cache headers applied; redirect if session missing.
Actual Results	All functions executed correctly; results displayed accurately with proper handling.
Status	Pass
Comments	Display module functions as expected with accurate data and error handling.

6.1.6 Bubble Game Test Case

Table 6.6: Test Case 8 - Bubble Game Functionality

Module Name	Bubble Game - Stress Relief Activity
Test Case ID	TC008
Use Case ID	UC-04
Tester Names	Asad Ali Khan, Sana Zia
Pre-Requisites	User must be logged in and system should be running with active database connection.
Test Case Description	To verify bubble game level completion and session data saving.
Test Steps	1. Navigate to bubble game page 2. Select level (calm/focus/energy) 3. Complete game session 4. Submit data via POST 5. Verify database save 6. Check JSON response
Test Inputs	Level: "calm", Score: 80, Duration: 60 seconds
Expected Results	1. Game page loads successfully 2. Data saved to BubbleGameSessions table
Actual Results	1. Page loaded successfully 2. Data saved correctly to database 3. Success response received 4. All functionality working properly
Status	Pass
Comments	Bubble game works correctly. Session saving and database operations function as expected.

6.1.7 Puzzle Game Test Case

Table 6.7: Test Case 9 - Puzzle Game Functionality

Module Name	Puzzle Game - Cognitive Activity
Test Case ID	TC009
Use Case ID	UC-04
Tester Names	Asad Ali Khan, Sana Zia
Pre-Requisites	User must be logged in and system should be active with database connection established.
Test Case Description	To verify puzzle game completion and session data saving.
Test Steps	1. Navigate to puzzle game page 2. Complete puzzle session 3. Submit points and duration via POST 4. Verify database insertion 5. Check JSON response
Test Inputs	Points: 400, Duration: 4 minutes
Expected Results	1. Game page loads successfully 2. Session data saved to PuzzleGameSessions table
Actual Results	1. Page loaded correctly 2. Data successfully saved to database 3. Success response received 4. All functionality working properly
Status	Pass
Comments	Puzzle game functionality works correctly. Session tracking and validation function as expected.

6.1.8 Mindfulness Activity Test Case

Table 6.8: Test Case 10 - Mindfulness Activity

Module Name	Mindfulness - Meditation Activity
Test Case ID	TC010
Use Case ID	UC-04
Tester Names	Asad Ali Khan, Sana Zia
Pre-Requisites	User must be logged in and authenticated session should be active.
Test Case Description	To verify mindfulness page access and user interaction.
Test Steps	1. Navigate to mindfulness page 2. Verify user authentication 3. Check page rendering 4. Validate assessment status
Test Inputs	User session with valid user_id
Expected Results	1. Mindfulness page loads successfully 2. User authentication verified 3. Template rendered correctly 4. Assessment status displayed properly
Actual Results	1. Page accessed successfully 2. Authentication working correctly 3. Template rendered properly 4. All functionality working as expected
Status	Pass
Comments	Mindfulness page functionality works correctly. Authentication and rendering function as expected.

6.1.9 Breathing Exercise Session Test Case

Table 6.9: Test Case 11 - Breathing Exercise Session

Module Name	Breathing Exercise - Session Management
Test Case ID	TC011
Use Case ID	UC-04
Tester Names	Asad Ali Khan, Sana Zia
Pre-Requisites	User must be logged in with an active session and database connection.
Test Case Description	To verify breathing exercise page access and session data saving.
Test Steps	1. Navigate to breathing exercise page via GET request 2. Complete breathing exercise session 3. Submit cycles and duration via POST request 4. Verify session data saved to BreathingSessions table
Test Inputs	Cycles Completed: 5, Duration: 3 minutes
Expected Results	1. Breathing page loads successfully 2. Session data inserted into BreathingSessions table 3. Success message displayed
Actual Results	1. Page loaded correctly with authentication 2. Session data successfully saved to database 3. Success response received with correct message 4. All functionality working as expected
Status	Pass
Comments	Breathing exercise functionality works correctly. Session saving and page rendering function as expected.

6.1.10 Chatbot Functionality Test Case

Table 6.10: Test Case 12 - Chatbot Response and Emotional Support

Module Name	Chatbot - AI Conversational Support
Test Case ID	TC012
Use Case ID	UC-05
Tester Names	Asad Ali Khan, Sana Zia
Test Case Description	To verify chatbot responses, emotional support accuracy, and stress management guidance through AI conversation.
Pre-Requisites	User logged in; chatbot page accessible; AI model loaded; database and session active.
Test Steps	1. Navigate to chatbot interface 2. Send stress-related queries 3. Test emotional and stress management responses 4. Verify chat history (10-message limit) 5. Check invalid input handling 6. Confirm conversation stored in database
Test Inputs	Sample messages about stress, anxiety, sleep issues, and time management.
Expected Results	1. Chatbot provides empathetic and relevant responses 2. Maintains session history and saves conversation to database 3. Returns valid JSON responses 4. Handles invalid inputs properly
Actual Results	1. Chatbot responded with emotional and practical support 2. History and database logging worked correctly 3. Responses were context-aware and well-formatted 4. Invalid inputs handled appropriately
Status	Pass
Comments	Chatbot performed effectively with accurate emotional support and proper session handling.

6.1.11 Dashboard Display Test Case

Table 6.11: Test Case 13 - Dashboard Data Display

Module Name	Dashboard - User Data Aggregation
Test Case ID	TC013
Tester Names	Asad Ali Khan, Sana Zia
Test Case Description	To verify that the dashboard retrieves and displays data from multiple tables with proper database connection and error handling.
Pre-Requisites	User logged in; database connected; completed assessments and activity records available.
Test Steps	1. Open dashboard with valid session 2. Verify ODBC connection setup 3. Retrieve user info, demographics, and assessments 4. Load expert profiles and activity sessions 5. Display appointments and recent chatbot conversations 6. Ensure connection closure and error handling
Test Inputs	Valid user session with existing assessment, activity, and appointment data.
Expected Results	1. Dashboard loads with all user-related data accurately 2. Latest assessments and demographics displayed properly 3. Expert profiles, sessions, and appointments shown correctly 4. Recent conversations retrieved and formatted 5. All database connections closed properly 6. Exceptions handled gracefully with fallback rendering
Actual Results	1. Data retrieved successfully from all related tables 2. Dashboard displayed accurate and formatted data 3. Assessment and activity details shown correctly 4. Connections managed efficiently with proper cleanup 5. Error handling and fallback rendering verified
Status	Pass
Comments	Dashboard integrates multiple modules and displays user data efficiently with proper connection management, error handling, and organized output.

6.1.12 Report Generation Test Case

Table 6.12: Test Case 14 - Mental Health Report Generation

Module Name	Report Generation - PDF Mental Health Report
Test Case ID	TC014
Use Case ID	UC-10
Tester Names	Asad Ali Khan, Sana Zia
Test Case Description	To verify that the system generates a complete PDF report containing assessment, demographic, expert, and appointment data.
Pre-Requisites	User logged in; assessment completed; database connected; wkhtmltopdf and CSS file available.
Test Steps	1. Access /report route with valid session. 2. Retrieve demographic, assessment, and expert data. 3. Fetch latest appointment and score reference info. 4. Generate unique report ID and insert record in Reports table. 5. Render HTML report with all user data. 6. Generate PDF using wkhtmltopdf and CSS styling. 7. Verify proper headers and file download.
Test Inputs	Valid user session with assessment, demographic, expert, and appointment data; wkhtmltopdf configuration; CSS path.
Expected Results	1. Data retrieved from all relevant tables. 2. Unique report ID generated (RPT[YYYYMMDD]-[XXXX]). 3. Record inserted into Reports table with timestamp. 4. HTML rendered correctly with complete sections. 5. PDF generated with proper formatting and styling. 6. Download headers applied correctly. 7. File downloaded as <code>mental_health_report.pdf</code>.
Actual Results	1. All data retrieved and formatted accurately. 2. Report ID generated and record inserted successfully. 3. PDF created with correct layout and CSS design. 4. Download functionality verified and working.
Status	Pass
Comments	Report generation functions correctly. The system integrates data from multiple tables, generates unique IDs, and produces a well-formatted downloadable PDF.

6.1.13 Appointment Booking Test Case

Table 6.13: Test Case 15 - Doctor Appointment Booking

Module Name	Appointment Booking - Doctor Consultation
Test Case ID	TC015
Use Case ID	UC-12
Tester Names	Asad Ali Khan, Sana Zia
Test Case Description	To verify appointment booking functionality with validation, duplicate prevention, and proper database operations.
Pre-Requisites	User logged in; database connected; list of doctors available; valid appointment slots active.
Test Steps	1. Access <code>/book_appointment</code> route. 2. Load user data (name, email, phone) from <code>Users</code> table. 3. Select doctor from available list. 4. Fill appointment form with required details. 5. Submit form via <code>/submit_appointment</code> POST request. 6. Verify monthly appointment limit (one per doctor per month). 7. Check duplicate appointment prevention for same slot. 8. Validate slot availability across users. 9. Insert new appointment with status <code>Pending</code>. 10. Verify success message and page redirection.
Test Inputs	Doctor: Dr. Sarah Ahmed; Date: 2024-12-15; Time: 10:00 AM; Reason: Stress consultation; Type: In-person.
Expected Results	1. User data retrieved and pre-filled correctly. 2. Monthly limit prevents multiple bookings per doctor. 3. Duplicate check blocks same slot rebooking. 4. Slot availability validation works for all users. 5. Appointment inserted with complete details and <code>Pending</code> status. 6. Success message displayed. 7. User redirected to booking page.
Actual Results	1. User data loaded and form pre-populated correctly. 2. Monthly booking limit enforced. 3. Duplicate prevention successful. 4. Slot validation functional across users. 5. Appointment record created with correct data and status. 6. Success message shown with proper feedback. 7. Redirection works correctly.
Status	Pass
Comments	Appointment booking works efficiently with proper validation, duplicate prevention, and smooth user feedback and redirection.

6.1.14 Appointment Validation Error Handling Test Case

Table 6.14: Test Case 16 - Appointment Booking Error Validation

Module Name	Appointment Booking - Error Handling
Test Case ID	TC016
Use Case ID	UC-12
Tester Names	Asad Ali Khan, Sana Zia
Test Case Description	To verify appointment booking error handling for various invalid scenarios
Test Steps	1. Attempt booking second appointment with same doctor this month 2. Try booking already taken time slot 3. Attempt duplicate booking by same user 4. Test database connection error handling 5. Verify appropriate error messages display
Test Scenarios	• Monthly limit exceeded (same doctor) • Slot already booked by another user • User trying to rebook same slot • Database connectivity issues
Expected Results	1. Error: "Already have appointment with doctor this month" 2. Error: "This slot is already booked" 3. Error: "You already booked this slot" 4. Error: "Error booking appointment. Please try again"
Actual Results	1. Monthly limit error displayed correctly 2. Slot conflict message shown properly 3. Duplicate booking prevented with clear message 4. Database errors handled gracefully with user-friendly messages
Status	Pass
Comments	Error handling comprehensive with clear user feedback. System prevents conflicts and provides appropriate guidance for resolution.

6.1.15 User Logout Test Case

Table 6.15: Test Case 17 - User Session Logout

Module Name	User Logout - Session Management
Test Case ID	TC017
Use Case ID	UC-11
Tester Names	Asad Ali Khan, Sana Zia
Test Case Description	To verify user logout functionality clears session data and redirects to login page
Pre-Requisites	User logged in with active session, Valid user_id in session
Test Steps	1. Navigate to /logout route while logged in 2. Verify session.clear() removes all session data 3. Check redirection to login page 4. Confirm logout success message display 5. Verify user cannot access protected pages without re-login
Test Inputs	Active user session with user_id, Protected page URLs
Expected Results	1. All session data cleared successfully 2. User redirected to login page 3. Success message "Logged out successfully" displayed 4. Access to protected pages requires re-authentication
Actual Results	1. Session data cleared completely 2. Redirection to login page working correctly 3. Logout success message displayed properly 4. Protected pages redirect to login as expected
Status	Pass
Comments	Logout functionality works correctly. Session management and security measures function as expected.

6.1.16 Admin Dashboard Test Case

Table 6.16: Test Case 18 - Admin Dashboard Management

Module Name	Admin Dashboard - Data Management
Test Case ID	TC018
Use Case ID	UC-14
Tester Names	Asad Ali Khan, Sana Zia
Test Case Description	To verify admin dashboard functionality and API endpoint management
Pre-Requisites	Admin logged in, Database connected, User data available
Test Steps	1. Navigate to /admin_dashboard with admin session 2. Test /api/admin/users, assessments, appointments endpoints 3. Verify /api/admin/chatbot-ratings statistics 4. Test user deletion via DELETE request 5. Confirm JSON responses and data formatting
Test Inputs	Admin session, API endpoints, User IDs
Expected Results	1. Dashboard loads with data overview and authentication 2. APIs return JSON with statistics and user details 3. Assessment and appointment data display correctly 4. User deletion removes related data with transaction handling
Actual Results	1. Dashboard loaded successfully with admin functionality 2. APIs returned formatted JSON with statistics 3. Data displayed accurately with correct metrics 4. User deletion worked with cascading removal 5. Appointments status changing and confirmation is working
Status	Pass
Comments	Admin dashboard functions correctly. All API endpoints work with proper data formatting.

6.1.17 Admin Logout Test Case

Table 6.17: Test Case 19 - Admin Session Logout

Module Name	Admin Logout - Session Management
Test Case ID	TC019
Tester Names	Asad Ali Khan, Sana Zia
Test Case Description	To verify admin logout functionality clears admin session and redirects to login page
Pre-Requisites	Admin logged in with active session, Valid admin_id and role in session
Test Steps	1. Navigate to /admin_logout route while logged in as admin 2. Verify session.clear() removes all admin session data 3. Check redirection to admin login page 4. Confirm logout success message display 5. Verify admin cannot access protected admin pages without re-login
Test Inputs	Active admin session with admin_id and role='admin', Protected admin URLs
Expected Results	1. All admin session data cleared successfully 2. Admin redirected to admin login page 3. Success message "Admin logged out successfully" displayed 4. Access to admin pages requires re-authentication
Actual Results	1. Admin session data cleared completely 2. Redirection to admin login page working correctly 3. Logout success message displayed properly 4. Protected admin pages redirect to login as expected
Status	Pass
Comments	Admin logout functionality works correctly. Admin session management and security measures function as expected.

6.2 Usability Testing

The critically important type of evaluation is the usability testing that evaluates the effectiveness and efficiency with which end-users can work with the AI-Based Student Stress Management System. This testing will be devoted to the user experience features such as the ease of the interface, the ease of navigation, and the overall satisfaction of the user with the experience of using stress assessment tools, therapeutic games, and chatbot communication, as well as booking an appointment. The main aim is to come up with usability obstacles that may stop students utilizing the mental health support system and that stressed students can have easier access to help without further nuisance by complicated interfaces. The actual student participants in usability testing conduct normal procedures e.g. stress assessment, therapeutic activities, and making counseling appointments in the presence of observers noting problems, areas of confusion, and ways of making it better. This testing has a direct impact on the interface design changes that are aimed at developing the more accessible and user-friendly mental health platform that meets the needs of consistent engagement and support-seeking behavior among students.

6.2.1 User Interface Navigation Testing

The user interface navigation testing determines the level of intuitiveness of the user movements across various parts of the AI-Based Student Stress Management System. The testing is paid attention to the menu availability, transition, breadcrumb navigation, and the logical progress of the assessment modules, therapeutic activities, and support functions.

Table 6.18: Usability Test Case 1 - User Interface Navigation

Module Name	User Interface Navigation
Test Case ID	UTC001
Tester Names	Asad Ali Khan, Sana Zia
Test Case Description	To evaluate user ability to navigate between main system components without confusion or excessive clicks
Participants	15 Bahria University students (undergraduate and graduate levels)
Task Scenarios	1. Navigate from homepage to stress assessment 2. Access therapeutic games from main dashboard 3. Find and use chatbot support feature 4. Book appointment with counselor 5. Return to previous assessment results
Success Metrics	• Task completion rate > 90% • Average clicks to complete task < 4 • Time to complete navigation < 30 seconds • User satisfaction rating > 4/5
Observed Results	• 93% task completion rate achieved • Average 3.2 clicks per navigation task • Mean completion time: 24 seconds • User satisfaction: 4.3/5 average rating

6.2.2 Assessment Form Usability Testing

Assessment form usability testing helps to test the user experience under stress, anxiety and depression questionnaire. The testing is done on the clarity of forms, understanding questions, ease of use in response mechanism and overall satisfaction with assessment completion.

Table 6.19: Usability Test Case 2 - Assessment Form User Experience

Module Name	Assessment Form Usability
Test Case ID	UTC002
Tester Names	Asad Ali Khan, Sana Zia
Test Case Description	To assess user experience and completion rates for comprehensive mental health assessment forms
Participants	20 Bahria University students with varying stress levels and academic backgrounds
Task Scenarios	1. Complete demographic information section 2. Answer stress assessment questions (10 items) 3. Complete anxiety evaluation (7 items) 4. Finish depression screening (9 items) 5. Review and submit complete assessment
Success Metrics	• Form completion rate > 95% • Average completion time < 8 minutes • Question clarity rating > 4.2/5 • Form abandonment rate < 5%
Observed Results	• 97% form completion rate achieved • Average completion time: 6.8 minutes • Question clarity rating: 4.4/5 • Form abandonment rate: 2.5%

6.2.3 Chatbot Interaction Usability Testing

The usability testing on chatbot interaction determines how well the conversational AI can offer emotional support and stress management advice. In this testing, the relevance of the responses, the flow of the conversation, and the user satisfaction with the AI-based counseling support are evaluated.

Table 6.20: Usability Test Case 4 - Chatbot Conversational Experience

Module Name	Chatbot Interaction Usability
Test Case ID	UTC004
Tester Names	Asad Ali Khan, Sana Zia
Test Case Description	To evaluate chatbot's ability to provide meaningful emotional support and maintain engaging conversations with stressed students
Participants	my class fellows and my freinds were the participants
Task Scenarios	1. Initiate conversation about academic stress 2. Request specific coping strategies for anxiety 3. Seek guidance for time management during exams 4. Ask for emotional support during difficult periods 5. Evaluate conversation quality and helpfulness
Success Metrics	• Response relevance rating > 4.1/5 • Conversation satisfaction > 4.0/5 • Perceived helpfulness > 4.2/5 • Willingness to use again > 85%
Observed Results	• Response relevance rating: 4.3/5 • Conversation satisfaction: 4.1/5 • Perceived helpfulness: 4.4/5 • Willingness to reuse: 88%

6.3 Performance Testing

Performance testing assesses the capability of the AI-Based Student Stress Management Web Application to operate under different loads, effectively use machine learning predictions and ensure the most optimal response times in the diverse cases of usage. This testing means that the web system is capable of serving multiple users simultaneously by supporting stress tests, therapeutic intervention, and chatbot communication without affecting performance. It is concerned with the web application responsiveness, server throughput capacity and scalability during peak usage times when the students need instant mental health assistance.

6.3.1 Overall System Performance Testing

Table 6.21: Performance Test Case

Module Name	Web Application Performance
Test Case ID	PTC001
Tester Name	Asad Ali Khan
Test Case Description	Verify that the AI-Based Student Stress Management Web Application performs well under normal and peak conditions, such as page loading times and response times for various web-based actions.
Pre-Requisites	The Web Application is deployed and running on server.
Test Scenario	Multiple users are accessing web application features concurrently.
Test Steps	1. Open the AI-Based Student Stress Management Web Application in browser. 2. Measure the time taken for web pages to load. 3. Measure the time taken for web actions like logging in, assessment submission, chatbot interaction, etc. 4. Test the web application under different load conditions (multiple users perform various web tasks).
Test Input	Web actions like logging in, assessment submission, chatbot queries, dashboard loading, appointment booking, etc.
Expected Result	1. The web application should load in less than 5 seconds. 2. Each web task (e.g., login, assessment) should take less than 3 seconds to complete. 3. The web application should function smoothly under normal and peak loads. 4. Web system should support minimum 100 concurrent users efficiently.
Actual Result	1. The web application loaded in 3 seconds. 2. Web tasks were completed within the expected time frame. 3. Web system handled 120 concurrent users successfully. 4. All web operations performed smoothly under various load conditions.
Status	Pass
Comments	The web application is responsive and performs well under normal conditions.

6.4 Compatibility Testing

Compatibility testing evaluates the AI-Based Student Stress Management System’s functionality across different web browsers, operating systems, and devices to ensure consistent user experience and accessibility. This testing verifies that the web application works seamlessly on various platforms including desktop computers, tablets, and mobile devices with different screen sizes and resolutions.

6.4.1 Cross-Platform Compatibility Testing

Table 6.22: Compatibility Test Case - Cross-Platform Web Application Testing

Module Name	Cross-Platform Compatibility
Test Case ID	CTC001
Tester Name	Asad Ali Khan
Test Case Description	Verify that the AI-Based Student Stress Management System is compatible with various devices, operating systems (Windows/MacOS/Linux), and web browsers.
Pre-Requisites	The web application is deployed and running on different devices and operating systems.
Environment Information	• OS: Windows • System: Web Browser/computer/mobile
Test Scenario	Students are accessing the web application from different devices and browsers.
Test Steps	1. Test the AI-Based Student Stress Management System on various devices (e.g., Windows laptops, tablets, smartphones). 2. Test on different operating systems (Windows versions, MacOS versions). 3. Test on different web browsers (Chrome, Firefox, Safari, Edge). 4. Verify responsive design and functionality across different screen sizes.
Test Input	Devices with different OS (Windows, MacOS) and browsers (Chrome, Firefox, Safari, Edge).
Expected Result	The web application should function properly on various devices, operating systems, and browsers with consistent user interface and functionality.
Actual Result	The web application functioned correctly across devices, operating systems, and browser versions with responsive design working properly.
Status	Pass
Comments	The AI-Based Student Stress Management System is compatible across different devices, OS versions, and web browsers.

6.5 Exception Handling

Exception handling testing is used to test the capability of the AI-Based Student Stress Management System to recover gracefully under unplanned or unexpected errors, system failures, and edge cases, which could happen during normal operation. This type of testing is done to make sure that the web application is stable and they will give meaningful error messages to the users in case of problems like login authentication issues, network connectivity problems with chatbots, or data loading problems. The main goal is to ensure that the system is able to recover under different types of error conditions and that such a recovery is not done at the expense of data integrity or user experience and that suitable error data is logged to aid debugging. Exception handling is also essential to a mental health support system because students who want assistance should not face a system crash or get an incoherent error message that may make them feel discouraged to use the platform.

6.5.1 Common Exception

The AI-Based Student Stress Management System frequently encounters the following exception scenarios:

- **Login Authentication Exceptions:** User credentials that are invalid or authentication attempts that fail. Handled through secure password verification, input validation, and unambiguous error messages that direct users to reset their passwords or try again.
- **Chatbot Network Exceptions:** Problems with network connectivity and service timeouts during chatbot chats. Resolved using timeout handling, connection retry mechanisms, and fallback offline responses when network is unavailable.
- **Data Loading Exceptions:** Incomplete data retrieval for user dashboards and assessments and database query failures. Managed through error catching, default data display, and automatic retry attempts with user notification of loading issues.

6.6 Load Testing

The load testing will be used to test the capacity of AI-Based Student Stress Management System to achieve multiple concurrent users and large traffic volumes without degrading performance. This test is done to ensure the web application is able to handle peak usage situations where the numbers of students using the application at the same time are stress assessments, therapeutic activities, and support services. The initial aim is to determine the performance bottlenecks, system throughput, and ensure that the response times are satisfactory when the system is at full load to ensure that the system is not under strain.

during periods of exams or stress awareness campaigns as witnessed in university mental health platforms.

6.6.1 System Load Performance Testing

Table 6.23: Load Test Case - System Load Testing

Module Name	Load Testing
Test Case ID	LTC001
Tester Name	Asad Ali Khan
Test Case Description	Verify that the AI-Based Student Stress Management System can handle traffic from 100-150 users simultaneously without performance degradation.
Pre-Requisites	The system is running and set to simulate multiple users accessing it at the same time.
Environment Information	• OS: Windows • System: Web Browser/computer/mobile
Test Scenario	Students are accessing stress assessments, chatbot interactions, and therapeutic activities simultaneously.
Test Steps	1. Simulate 100-150 users accessing the system at the same time. 2. Monitor response times for each action (e.g., login, assessment submission, chatbot interaction). 3. Check for any performance degradation or system crashes.
Test Input	Simulated users performing various actions like login, assessment completion, chatbot conversations, appointment booking, and therapeutic activities.
Expected Result	1. The system should remain stable and perform without crashing. 2. User actions should be processed with minimal delay (less than 5 seconds).
Actual Result	1. The system handled the traffic smoothly with no crashes or performance issues.
Status	Pass
Comments	The AI-Based Student Stress Management System performs well under heavy load conditions.

6.7 Security Testing

Security testing ensures the AI-Based Student Stress Management System protects sensitive student data, prevents unauthorized access, and maintains confidentiality and integrity.

6.7.1 Authentication and Authorization Security Testing

Table 6.24: Security Test Case

Module Name	Authentication and Authorization Security
Test Case ID	STC001
Tester Name	Asad Ali Khan
Test Case Description	Verify that the AI-Based Student Stress Management System implements proper security measures for user authentication, data privacy, and data encryption.
Pre-Requisites	The system is installed and accessible.
Environment Information	• OS: Windows • System: Web Browser/computer/mobile
Test Scenario	Students are accessing the system with authentication and security validation.
Test Steps	1. Test the login process with invalid credentials (e.g., wrong password). 2. Test password encryption (ensure it is stored securely). 3. Check the system for role-based authentication (if applicable).
Test Input	1. Invalid credentials. 2. Test user password input.
Expected Result	1. User login should fail with invalid credentials. 2. Password should be encrypted in database. 3. Role-based authentication should be available if enabled.
Actual Result	1. Login failed with incorrect credentials. 2. Password was securely encrypted.
Status	Pass
Comments	The AI-Based Student Stress Management System demonstrates robust security measures for protecting sensitive mental health data with proper authentication, authorization, and data encryption.

6.8 Installation Testing

The installation testing is conducted to assess the process of deployment and installation of the AI-Based Student Stress Management System in various server settings, and configurations. This testing determines that all system components such as the Flask web application, the SQL Server database, machine learning models and necessary dependencies are capable of being installed and configured successfully on target systems. The testing includes pre-requisite software setup (Python, Flask framework, database drivers), creation of database structure and initial populating database data, loading and validation of machine learning model, configuration of web server, and system start-up. The installation testing will be performed to verify that the mental health platform is reliable to be deployed in the university IT environment and that it is functioning correctly by verifying the correct functionality, database connectivity, and user access verification to ensure smooth availability of the system to support the student mental health services.

Chapter 7

Conclusions

The AI-Based Stress Management System design is a successful attempt to show how the technology can be of immense assistance in the field of ensuring the psychological comfort of students. The system offers a convenient experience of tracking and relieving stress, with smart assessment, interactive apps and individual feedback. It is easy to use and being user-friendly, it can be adapted to fulfill the needs of customers since its integration with AI and data analytics makes it more accurate and versatile. The project can provide the most appropriate strategy of stress management, which is the combination of relaxation practices, endorsing chatbots, and self-assessment systems. The system helps in early identification and management of stress among the students and this translates to healthy academic and personal lives. Moreover, the study is consistent with the purpose of the Well-Being Center in Bahria University that assists in the mental health and resilience of students. Through this system, the Well-Being Center will unite all of its online support services and will target more students. Generally, the project is successful in terms of accomplishing its purpose of conquering the technological divide and mental health assistance, and can be enhanced and increased in the future.

7.1 Lessons Learned

This project equipped us with key skills in system development and insights into technology's role in mental health. We learned the value of creating user-friendly systems, ensuring privacy and ethical responsibility, training AI models for reliable results, and enhancing teamwork and time management. The experience also highlighted continuous learning and demonstrated the system's potential to support Bahria University's Well-Being Center.

7.2 Future Improvements

The AI-Based Student Stress Management System has a great potential to grow and develop. The following improvements to the system would make it more effective and user-friendly:

- **Facial Expression Recognition:** Add facial expression recognition: Add computer vision technology in real-time emotional analysis and detecting stress level.
- **Enhanced AI Chatbot:** Improve the AI chatbot to give more contextual, empathetic and personal responses according to the preferences and history of the user.
- **Developing Mobile Applications:** Harness a mobile version of the application that keeps in tandem with the web platform so that it can be easily accessed at any moment or place.
- **Well-Being Center Integration:** Link the system with the Well-Being Center of Bahria University to offer direct counselor support and timely professional intervention in the period of high stress.

Appendix A

User Manual

A.1 Purpose

The AI-Based Student Stress Management System is developed with the perspective of implementing stress management measures among the students effectively with assessments, relaxation exercises, communication with the chatbot, and professional assistance, referring to the Well- Being Center of Bahria University as the extra help.

A.2 System Requirements

The following requirements will have to be satisfied to facilitate smooth running of the system:

- Device: Laptop, Desktop, or Smartphone
- Browser: Google Chrome, Microsoft Edge, or Mozilla Firefox
- Internet: Stable Internet Connection
- Account: Registered User Credentials

A.3 System Access

- Click on the system link on your favorite browser.
- Click on Register to form a new account or use the existing credentials and Click on login.
- Upon login the system will lead to the Dashboard.

A.4 Main User Steps

Step 1 – Login or Register

- New members have to sign up by providing authentic information.
- The current users are able to log in by simply using their email and password.

Step 2 – Stress Assessment

- On the logging in page, after the click on the stress assessment."
- Complete the form and hand in your replies.
- Like your answers are analysed and your Stress Level (Low / Moderate / High) is revealed.
- Recommendations are given against the results.

Step 3 – Chatbot Interaction

- Before or after the assessment You are able to communicate with the Chatbot.
- Click on Chatbot and type in what you are looking or how you feel.
- The chatbot does give relaxation tips, self-care tips, and inspirational responses.

Step 4 – Stress Relief Activities / Games

- In case your stress level is excessive, you will be directed to do stress-relief activities or games.
- Go to the section of activities to play relaxing games or attempt breathing exercises.
- These exercises can be used to relieve stress and take a break to be reassessed.

Step 5 – Chatbot Follow-up

- After the activities, interact with the chatbot for further guidance.
- The chat robot will make you look back and give recommendations.

Step 6 – Dashboard Overview

The Dashboard gives access to all main features:

- Doctor's Appointment Booking
- Report Generation
- Stress History and Progress
- Chatbot Interaction
- Profile Management

Step 7 – Doctor's Appointment

- Click on Book Appointment on the dashboard.

- Choose your counselor, date and time at the Well-Being Center of Bahria University and select what you want.
- Wait until an appointment is confirmed and it will be placed in the dashboard.

Step 8 – Generate Report

- Click "Generate Report" to view or download your progress summary.
- The report includes:
 - Stress Assessment Results
 - Activity Performance
 - Appointment Records

A.5 Logout

- Click the "Logout" button to safely exit your account.

A.6 Support

- For any technical or psychological assistance, contact the System Administrator or the Bahria University Well-Being Center through the support section.

A.7 Note

This AI-Based Student Stress Management System is intended to provide digital support and self-help tools for stress reduction. It does not replace consultation with a professional psychologist or counselor. Users experiencing severe stress or mental health issues are strongly advised to seek immediate help from qualified mental health professionals at the Bahria University Well-Being Center or other certified practitioners.

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