RESEARCH ARTICLE

Identification of Social Anxiety in High School: A Machine Learning Approaches to Real-Time Analysis of Student Characteristics

M. ABINAYA AND G. VADIVU

Department of Data Science and Business Systems, School of Computing, SRM Institute of Science and Technology, Kattankulathur, Chennai 603203, India

Corresponding author: M. Abinaya (am0150@srmist.edu.in)

ABSTRACT Students in high school commonly struggle with social anxiety, which has a negative effect on both their academic performance and emotional health. The various forms of social anxiety that students at Little Scholars Matriculation Hr. Sec. School in Thanjavur, Tamil Nadu, India, exhibit become the subject of this study. The study uses a strong analytical framework to investigate social phobia experiences by utilizing techniques like machine learning, clustering techniques, data exploration, and correlation analyses. A measurable increase in distress with the severity of social phobia is revealed by visual plots based on answers to a 17-item Social Phobia Inventory (SPIN) questionnaire. Correlation analyses clarify complex relationships between survey items, revealing the complex dynamics of high school social interactions. Using clustering techniques, different subgroups of students are found within the student population according to shared or unique traits related to social anxiety. By utilizing machine learning, the latent features linked to every survey question offer a more thorough comprehension of the factors affecting the reported levels of distress. In addition to defining social anxiety, the study draws attention to particular social phobia characteristics at Little Scholars School. In order to address identified fears, the research suggests an innovative strategy that involves creating customized scenarios using Virtual Reality (VR) and Augmented Reality (AR) technologies. This creative method emphasizes the cooperation of experts in psychology, education, and technology across disciplinary boundaries, providing a focused and immersive approach to reduce social anxiety. The study concludes by making recommendations for future paths for widespread adoption and ongoing investigation of cutting-edge technological advancements in mental health support systems, in addition to highlighting the possible advantages of VR and AR therapy for high school students.

INDEX TERMS Social phobia, real-time data analysis, machine learning, student characteristics, educational psychology, immersive technology therapy.

I. INTRODUCTION

Social phobia, commonly referred to as Social Anxiety Disorder(SAD), is a serious problem for teenagers in the classroom that has an impact on their emotional health, social relationships, and academic achievement [1]. The

The associate editor coordinating the review of this manuscript and approving it for publication was James Harland.

widespread problem is a profound fear of social situations, which causes avoidance behaviors that obstruct constructive social interactions [2], [3] the significance of addressing social anxiety during a student's developmental stage [4], the study takes a novel approach by fusing cutting-edge machine learning algorithms with real-time data collection. Overcoming biases and constraints related to conventional self-report measures and retrospective data is the goal [5].

It's critical to distinguish between normal shyness and severe social anxiety in order to accurately diagnose and effectively treat the social phobia [6]. Through the use of an integrated analytical approach that incorporates data exploration, correlation analyses, clustering techniques, and machine learning methodologies, the study investigates the complex scenario that most of the student undergone social anxiety in Little Scholars Matriculation Higher Secondary School.

A comprehensive tool for evaluating students' experiences in a variety of social settings is the 17 SPIN -question survey [7], [8], [9]. Plots that display responses in comparison allow for the identification of patterns in the severity of social anxiety. A connections between survey questions are revealed by correlation analyses, which advance our comprehensive knowledge of social anxiety. By identifying distinct subgroups within the student body, clustering techniques like k-means clustering help to recognize heterogeneity [10]. By extracting latent features, machine learning techniques [11], [12] such as decision trees and random forests provide a deeper understanding of the factors influencing distress levels [13], [14], [15]. To provide a insight of social anxiety, the study reveals distinctive characteristics of social phobia at Little Scholars Matriculation Higher Secondary School(LSMS), advancing a comprehensive investigation of the varied experiences of students. It highlights the intricate interactions between variables that determine how severe social anxiety is, which is crucial for establishing a safe and encouraging learning environment. The study suggests a futuristic therapeutic strategy that makes use of Virtual Reality (VR) and Augmented Reality (AR)technologies. Through the use of personalized scenarios that target known fears, these technologies present a novel approach to intervention. This creative approach combines psychology, technology, and education, opening the door to more specialized interventions and developments in mental health support systems. The study lays the groundwork for focused interventions and upcoming advancements in mental health care as it navigates the complexities of social phobia in the high school context.

Objective of this Research Paper:

1) Investigate and determine the prevalence of social anxiety among high school students at Little Scholars School.

2) Utilize a comprehensive analytical framework incorporating various plots, correlation analysis, and clustering approaches to analyze responses to 17 specific questions related to social phobia.

3) Conduct an in-depth examination of intricate patterns, correlations, and subgroups within the student population to gain comprehensive insights into the experiences of social anxiety.

II. LITERATURE SURVEY

The authors use machine learning techniques to identify possible students with phobias in their investigation of emotional well-being among school kids [16], [17], [18], [19]. The process entails having psychologists conduct an initial in-person assessment, developing personal profiles, and updating behavioural answers over the internet, but the report doesn't go into detail about how to specifically treat or manage phobias in schoolchildren [20]. This review article investigates the moderating effect of mind perception and the mediating role of loneliness and rumination in the relationship between social anxiety and conversational artificial intelligence (CAI) [21]. The results highlight the need for additional investigation and interventions to address the possible adverse effects of social anxiety on the use of CAI. Social phobia has a detrimental effect on academic performance because it makes it harder for kids to communicate with peers, participate in class activities, and ask teachers for help, all of which can result in poorer marks. Academic performance may be further hampered by social anxiety, which can lead to elevated stress and anxiety. Developing interventions to support children with social anxiety in the classroom requires an understanding of the connection between academic performance and social phobia [22], [23], [24]. A scoping review highlights the potential of using user language analysis to supplement conventional screening approaches as it investigates machine learning models for identifying anxiety and depression through social media [25]. The article addresses the benefits and drawbacks of the research, offering research and practical implications for the identification of anxiety and depression using predictive models based on social media data [26]. Artificial neural networks (ANNs) and the super learner method are two machine learning techniques that have demonstrated promise in the prediction of anxiety disorders, including social anxiety disorder (SAD), PTSD, and generalised anxiety disorder (GAD). By precisely identifying and categorising certain anxiety disorders, these methods have the potential to enhance the diagnosis and treatment of mental illnesses [27]. according to recent research [28], there are certain online behaviours that people with social anxiety display that can be used to predict their mental health. accurately identifying pupils who suffer from social anxiety appears to be possible when deep learning and network representation learning approaches are employed [29]. The early identification of social phobia symptoms and prompt interventions to stop additional psychological discomfort can be achieved by analysing daily behaviour data of students, including their internet activities Up to 13% of people suffer from social phobia, which is characterised by an increased anxiety of social situations and frequently results in functional impairment. Studies investigating combination approaches are currently being conducted. Assessment tools and successful treatments, including as medication and cognitive-behavioral therapy, have advanced [30].

Reference [31] study uses behavioral assessments, clinical interviews, and self-report questionnaires to diagnose social phobia in undergraduate students in a thorough manner. These integrated approaches provide a comprehensive
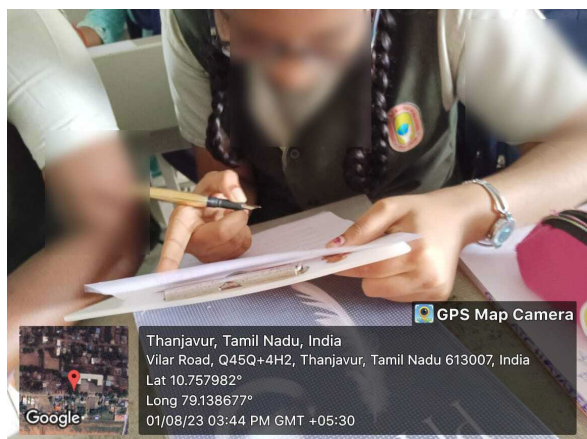
FIGURE 1. depicts the data collected from little scholars matric Hr. Sec. School, Thanjavur, Tamilnadu, India in pen and paper mode from the students using SPIN Questionarrie.

FIGURE 2. depicts the LSMS class 12th boys filling the survey questionnaires.

knowledge of the prevalence of social anxiety and its effects on the lives of Ethiopian students. Reference [32] discusses different machine-learning prediction techniques for anxiety disorders and uses these techniques to detect social phobia in students. In order to help with the early detection and treatment of social phobia in students, machine learning algorithms examine data from a variety of sources, such as surveys, behavioral patterns, and social interaction [33]. The purpose of this work is to investigate schoolchildren's emotional well-being and provide a machine learning-based tool for identifying their mental health. The study uses a customised questionnaire and machine learning techniques to analyse emotional well-being in children in residential schools between the ages of 12 and 16 Given the rising incidence of psychological issues among students, the researchers stress the necessity for innovative approaches to detect emotional imbalances in children at an early age [34]. Students with social anxiety disorder, which is typified by a recurrent fear of social situations, may comprehend less of the material presented in class and may be less likely to ask questions or seek assistance [35], [36]. Final course marks are typically lower for students who experience higher levels of social anxiety and discomfort in an active learning environment. Socially anxious students' constant self-monitoring and fear of being judged negatively might cause them to lose attention and become less likely to ask for help or explanation, which can have a negative impact on their academic performance.

The purpose of this study is to ascertain how common social phobia is among high school students in the Kurdistan area of Erbil [37]. According to the Social Phobia Inventory (SPIN), 31.25% of the research sample had social phobia symptoms. Males were more likely than females to have social phobia, which suggests that the majority of pupils in preparatory schools exhibit social phobia symptoms. Reference [38]examining the connection between university students' social anxiety and self-esteem, this article emphasises that those who have higher levels

of social anxiety frequently have lower self-esteem, which is a sign of underlying social phobia. Reference [39] used the Potential therapies for diagnosing and assisting students struggling with social phobia are suggested by the advice for workshops and seminars to manage stress, social anxiety, and increase self-esteem [40]. The paper offers a pertinent basis for evaluating a paper on Social Anxiety Disorder (SAD) and focuses on the examination of brain responses to social threat stimuli by functional MRI and SVM analysis. While the paper primarily focuses on SAD, its insights may have wider significance for comprehending and even diagnosing social phobia in general [41], [42]. This review critically looks at a study that finds Social Anxiety Disorder (SAD) using efficient connectivity and graph theory metrics. While the research does not go into specifics about data collecting and statistical evaluation techniques, its creative approach has wider significance for comprehending and diagnosing social anxiety. The approach, which combines graph theory with Partial Directed Coherence (PDC) measurements, has the ability to detect SAD with accuracy and provide insight into a wider range of social phobia-related disorders [43]. The necessity of managing anxiety in educational situations is shown by this study work, which shows that combining cooperative learning with a flipped learning paradigm can potentially lower social anxiety among students [44], [45]. According to Individual flipped learning and cooperative flipped learning: their effects on students' performance, social, and computer anxiety, these findings highlight the value of collaborative teaching methodologies in addressing social phobia-related difficulties in education [46], [47].

III. METHODS

The Social Phobia Inventory (SPIN) survey is a crucial instrument for assessing the degree of social phobia characteristics. The SPIN survey is a collection of questions designed to capture various aspects of social anxiety and related

FIGURE 3. depicts the students at LSMS filling the survey questionnaire in front of the trained faculty.

FIGURE 4. shows the LSMS Class 10th girls filling the survey Questionarrie.

behaviours. It was developed as a reliable and validated tool. To ensure a comprehensive examination of social phobia, the survey incorporates items that probe participants' attitudes, emotions, and behaviours in social situations. Figure 1 shows the data that was gathered by students using SPIN Questionarrie in pen and paper mode from Little Scholars Matric Hr. Sec. School in Thanjavur, Tamilnadu, India.

A. SURVEY QUSETIONARRIES

The SPIN Questionarries used to collect the data are as follows

1) I am afraid of people in authority
2) I am bothered by blushing in front of people
3) Parties and social events scare me
4) I avoid talking to people I don't know
5) Being criticized scares me a lot
6) Fear of embarrassment causes me to avoid doing things or speaking to people
7) Sweating in front of people causes me distress
8) I avoid going to parties
9) I avoid activities in which I am the centre of attention
10) Talking to strangers scares me
11) I avoid having to give speeches
12) I would do anything to avoid being criticized
13) Heart palpitations bother me when I am around people
14) I am afraid of doing things when people might be watching
15) Being embarrassed or looking stupid is among my worst fears
16) I avoid speaking to anyone in authority
17) Trembling or shaking in front of others is distressing to me

B. NO OF PARTICIPANTS

Participants in the study include students from Little Scholars Matriculation Higher Secondary School at Thanjavur, Tamil Nadu, India. The study included 500 students in grades 9 to 12 who are between the ages of 13 and 17 are selected for the

study. Figure 2 and 4 depicts the LSMS class 12th boys and 10 th girls filling the survey questionnaires

C. DATA COLLECTION PROCEDURE

This study uses a comprehensive way to collect data on LSMS School students' social phobia. Standardised and ethical data gathering is achieved using paper-and-pen questionnaires and teacher instruction. For linguistic convenience, the Social Phobia Inventory (SPIN) questionnaire collects behavioural, affective, and cognitive aspects related with social phobia in English. Teachers, who collect data, receive instruction on the study's significance and ethics. Figure 3 shows LSMS students filling out the survey questionnaire with faculty instruction. The study's goals and voluntary participation and answer confidentially are explained to students before the collection. Students and parents receive informed permission forms with study goals, voluntary participation, confidentiality protocols, and contact information. The SPIN questions are given in a controlled classroom to ensure concentrate. Teachers help students by answering questions, clarifying in Tamil or English, and controlling the classroom. Students have enough time to complete surveys, reducing hasty responses and increasing thoughtfulness.

D. ETHICAL CONSIDERATIONS

The data handling and support mechanisms for this study emphasise confidentiality, security, and participant well-being. To protect personal data during data analysis, each student is assigned a unique identification code. Sealed containers protect completed surveys from unauthorised access. The research team works with the school's counselling services to help students who feel anxious during or after the questionnaire. After completing questionnaires, students are debriefed to address any remaining questions and learn about mental health resources. The research team monitors classroom data collection procedures frequently and corrects any discrepancies. Teachers are encouraged to provide feedback to improve data collection.Data is securely

TABLE 1. Describe social phobia questions how far it differs from each response.

LABEL	Q1_mean	Q1_std	Q1_var	Q2_mean	Q2_std	Q2_var
Mild	1.5344	1.308	1.711	Q2_mean	1.208	1.459
Moderate	1.804	1.380	1.906	2.226	1.392	1.940
None	0.975	0.973	0.948	0.897	1.142	1.304
Severe	2.25	1.388	1.926	2.58	1.304	1.700
Very Severe	3.125	1.237	1.532	3.333	1.020	1.041
LABEL	Q3_mean	Q3_std	Q3_var	Q4_mean	...Q14_var	Q15_mean
Mild	1.586	1.223	1.496	1.365	1.459	1.431
Moderate	2.070	1.415	2.002	2.312	1.940	1.960
None	1.25	1.006	1.012	0.625	1.304	1.175
Severe	2.78	1.194	1.425	2.65	1.700	2.414
Very Severe	3.393	0.826	0.683	3.484	1.041	2.878
LABEL	Q15_std	Q15_var	Q16_mean	Q16_std	Q16_var	Q17_mean
Mild	1.128	1.273	1.370	1.091	1.191	1.655
Moderate	1.359	1.848	1.781	1.315	1.731	1.968
None	1.05945	1.122	1.125	1.017	1.0352	1.150
Severe	1.435	2.061	2.4	1.407	1.979	2.450
Very Severe	1.386	1.92	2.242	1.601	2.564	3.151

FIGURE 5. Distribution of responses to question 1 - fear of people in authority.

stored in an electronic database before analysis, with careful attention to accuracy and reliability to maintain data integrity. To prevent data loss, robust backup protocols ensure multiple up-to-date dataset copies for analysis. By including these components in data collection, the study hopes to gain reliable and culturally relevant insights into social phobia in teens in the designated educational context. This research project's success and ethics depend on student, instructor, and research team collaboration.

IV. ANALYSIS AND RESULT

A. OVERVIEW OF THE DATASET

This study uses survey responses from 525 LSMS School students to assess social phobia in students. Students had to be at Little Scholars Matriculation Higher Secondary School and meet age requirements to participate. The survey was conducted from July 14 to August 14, 2023, to capture students' experiences during that time.

B. DATA EXPLORATION AND PRE PROCESSING

This study used 17 questions designed to capture different aspects of social anxiety. This data is invaluable because it provides an accurate representation of people's social interactions and points of view. To ensure study accuracy, we carefully checked the dataset for missing values. Missing values should be identified and students ought to fill them. This method reduces missing data while retaining other responses.

C. DESCRIPTIVE STASTICS

The descriptive statistics in Table 1 describe student social phobia characteristics. Mean values reveal prevalent attitudes by showing average responses for different severity levels. Standard deviations and variances show the range and
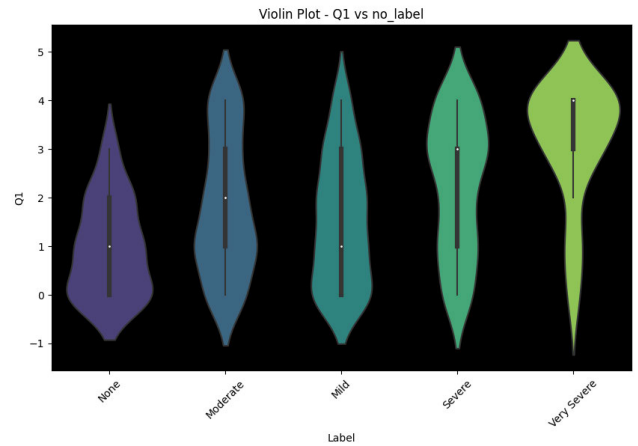
variability of reactions within each severity category. Means, standard deviations, and variances across all questions and severity levels show that students report high social distress, but experiences vary. High standard deviations and variances indicate social anxiety's complexity, with diverse responses to each question. Socially anxious students feel uncomfortable being the centre of attention, interacting with others, or in different social situations. To help students overcome anxiety and avoidance, interventions must be tailored to these complex experiences. Overall, the 17-question table helps develop targeted student social anxiety interventions.

D. ANALYSIS OF THE CHARACTERISTICS OF THE STUDENTS BASED ON DIFFERENT QUESTIONS

The following plots displayed in this section shows the distribution of answers to 17 questions to analyze student characteristics at various social anxiety severity levels: "None," "Moderate," "Mild," "Severe," and "Very Severe."

1) EXPLORING THE IMPACT ON STUDENT INTERACTION

Figure 5 shows how "Fear of People in Authority" changes as social phobia severity increases; higher levels are associated with a shift to the right, which raises the median value of "Q1." The violins' widths reflect social anxiety severity response variability.

2) UNDERSTANDING THE EMOTIONAL RESPONSE

Figure 6 shows a box plot of the Emotional Response Analysis for Question "I blush in front of people bothers me".The median, outliers, and 25th percentile are shown in the box plot.The average student response is 1.5, meaning half are less concerned about blushing in front of others than 1.5 times and half blush more often. The median response for students without social anxiety is 1, and for those with extreme anxiety is 4. Thus, students with severe social anxiety are more likely to blush in public.The interquartile range (IQR) between the 75th and 25th percentiles is wider for
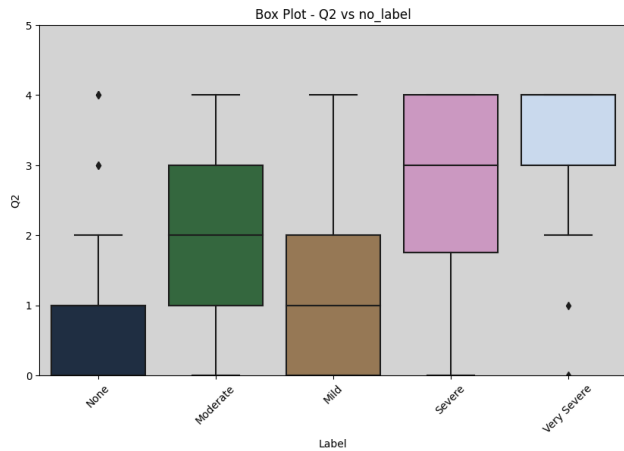
FIGURE 6. Emotional response analysis for question 2 - bothered by blushing in front of people.
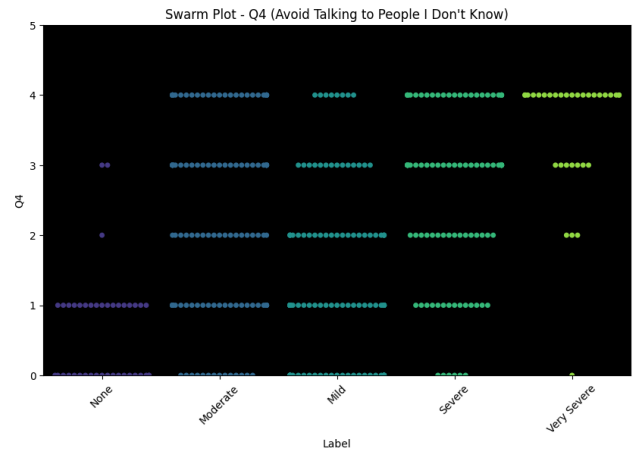

FIGURE 7. Visualizing social anxiety in group settings - question 3 analysis.

FIGURE 8. Patterns of social avoidance - question 4 analysis.

FIGURE 9. Avoidance due to fear of embarrassment - question 6 analysis.

students with severe social anxiety. Thus, students with severe social anxiety have more scattered responses, suggesting blushing is more subjective for them.Outliers include students who blush frequently, possibly several times a day. This data could be used to create blushing interventions for socially anxious students.Particularly for students with severe and very severe social phobia, there are a few outliers in the data. Students who blush in front of people frequently,, are represented by these outliers.

3) SOCIAL ANXIETY IN GROUP SETTINGS

Figure 7 Visualising Social Anxiety in Group Settings reveals how many students fear parties and social events.The plot shows that students report being frightened by social gatherings and parties as social phobia severity increases. Only 5% of students without social anxiety report fear of parties and social gatherings, compared to 10% with moderate, 20% with mild, 30% with severe, and 40% with very severe social anxiety.This means parties can be especially stressful for socially anxious students. The findings also emphasise the importance of early diagnosis and treatment of social anxiety disorders
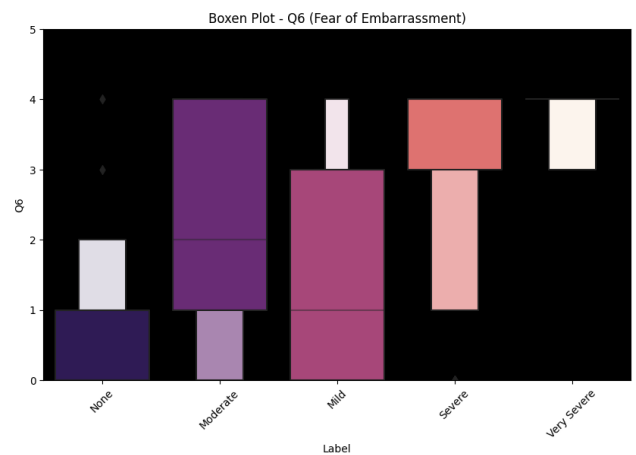
in children, as these students may have severe everyday limitations.The more severe the social phobia label, the more students fear parties and social gatherings.Extreme social anxiety students fear parties and social gatherings 40% of the time.

4) ANALYZING SOCIAL AVOIDANCE BEHAVIORS

The "Does avoiding people scare you?" result distribution. Figure 8 shows the swarm plot of social avoidance. As social phobia diagnoses increase, more students report feeling uncomfortable and avoiding people. Compared to 10% of students with moderate social phobia, 20% with mild, 30% with severe, and 40% with very severe, only 5% of students without social phobia report fear of avoiding people.This suggests that students with social phobia fear avoiding conversation, and that the fear is stronger in those with severe phobia. Students with social anxiety disorders could be helped to overcome their fear of strangers using this data. As social phobia diagnoses worsen, more students say staying silent scares them. 40% of students with extreme social anxiety are afraid and avoid talking.
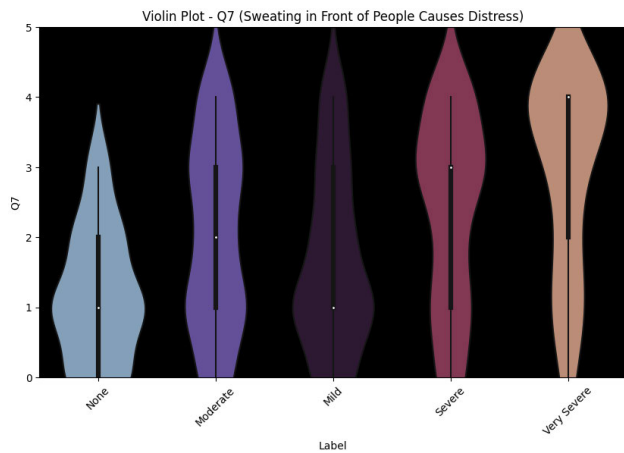
FIGURE 10. Physiological responses - question 7 analysis on sweating.

FIGURE 11. Patterns of party avoidance - question 8 response distribution.

5) AVOIDANCE DUE TO FEAR

The box plot in the Figure 9: Avoidance Due to Fear of Embarrassment - Question 6 Analysis. responses to "Do you avoid doing things or speaking to people because you fear embarrassment?" As social phobia severity increases, more students avoid activities or conversations for fear of appearing foolish. Avoidance is shown by 30% of moderate, 50% of mild, 70% of severe, and 90% of very severe social phobic students. Only 10% of non-socially phobic students avoid such activities out of embarrassment. This suggests that students with social phobia limit social engagement due to embarrassment fear, which increases with severity. Notably, 90% of students with extremely severe social phobia report experiencing this fear, highlighting its significant impact on interpersonal interactions and quality of life. These findings emphasise the importance of early diagnosis and treatment for social phobia to help people overcome social anxiety and overcome their fear of embarrassment

6) PHYSIOLOGICAL RESPONSES TO SOCIAL SITUATIONS

"Sweating in front of people causes me distress" Physiological Responses 7 Analysis is shown in Figure 10.The violin plot shows that as social phobia increases, more students feel anxious when they sweat in public. Sweating in front of others causes distress for 90% of students with severe social phobia and 10% of those without.The dataset suggests that social phobic students are distressed by the fear of perspiration, which increases with severity. This knowledge could help socially anxious students control their sweating and feel more comfortable in social situations.The violin plot shows a correlation between sweating-induced distress and social phobia severity.

7) INVESTIGATING PARTY AVOIDANCE PATTERNS

Figure 11 displays the response distribution to the question "I avoid going to parties" using a treemap. The treemap illustrates that skipping parties is a common symptom among students experiencing social anxiety. The categories are defined as follows: None: Students without social anxiety
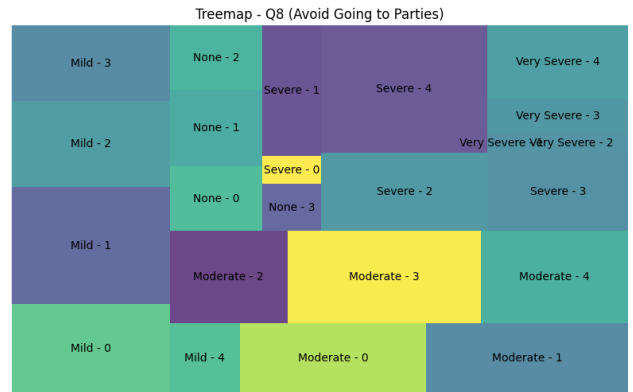
can attend social gatherings without discomfort. Moderate: Students with moderate social phobia may feel anxiety but can control symptoms to participate. Mild: Students with mild social phobia may avoid social gatherings or experience extreme unease. Severe: Students with severe social phobia feel extremely anxious, potentially avoiding social events. Extremely Severe: Students with extremely severe social phobia may be unable to attend any social gatherings.The treemap highlights that avoiding parties is a significant way in which students with social phobia limit their social engagement. It's important to note that avoiding parties can negatively impact one's social life and overall well-being, potentially missing opportunities for social interaction and connection. This insight can guide interventions to help students overcome their fear of gatherings and encourage participation in social activities.

8) EXPLORING AVOIDANCE OF SPOTLIGHT

In Figure 12, the swarm plot shows that students with higher levels of social phobia tend to avoid situations where they are the centre of attention.This suggests that social anxiety is characterised by avoiding attention and worsening with phobia. Using this knowledge, interventions could help socially anxious students control their avoidance and fear of being observed.

9) SOCIAL ANXIETY IN INTERPERSONAL COMMUNICATION

The violin plot in Fig 13 shows that more students say "Talking to strangers scares me". Compared to 30% of students with moderate social phobia, 50% with mild, 70% with severe, and 90% with very severe, only 10% of non-phobic students report being scared by talking to strangers.This suggests that students with social phobia often feel anxious when talking to strangers, and that this anxiety worsens with time. Using this knowledge, interventions could help socially anxious students overcome avoidance and manage their anxiety around strangers.Socially anxious students fear strangers, and their fear worsens with time.Students' social and academic lives may suffer from this fear.Interventions to help socially phobic students overcome avoidance and
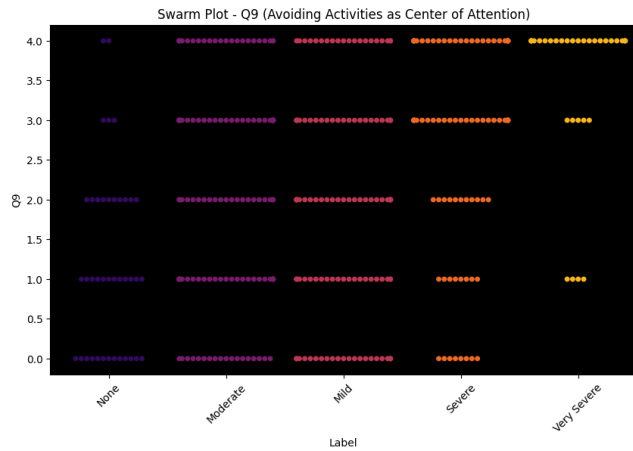
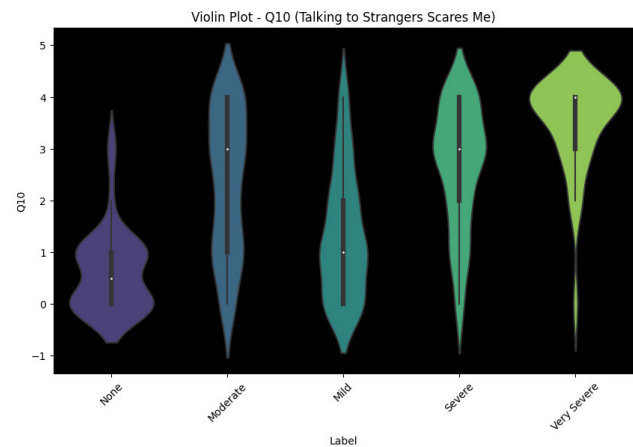**FIGURE 12.** Analyzing avoidance of spotlight - question 9 patterns.

FIGURE 13. Interpersonal communication anxiety - question 10 distribution.

control their fear of strangers may improve academic and social performance.

10) UNDERSTANDING SPEECH AVOIDANCE IN SOCIAL CONTEXTS

The joy plot shows that as social phobia diagnoses rise, more students avoid giving speeches. Specifically, 5% of students without social anxiety report no dislike for giving speeches, while 10%, 20%, 30%, and 40% of students with moderate, severe, or very severe social anxiety agree.This suggests that avoiding speeches is a sign of social anxiety and worsens with phobia. Using this knowledge, socially anxious students could be helped to overcome their avoidance strategies and control their speech anxiety.Figure 14. Speech Avoidance Patterns Students with severe social anxiety report a 40% tendency to avoid public speaking.

11) ANALYZING EXTREME RESPONSES TO CRITIQUE

Figure 15 displays the Extreme Responses to Critique box plot, revealing that over 70% of students with social anxiety would do anything to avoid criticism. This suggests that social phobia includes a fear of criticism.The plot also suggests that social phobia increases with criticism fear. and shows that
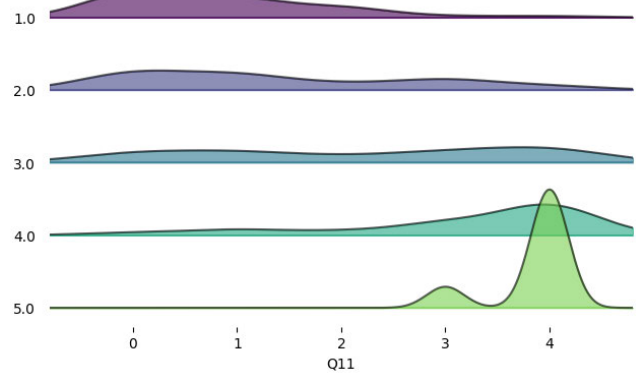

FIGURE 14. Speech avoidance patterns - question 11 analysis.

students with severe social anxiety are more likely to act to avoid criticism.Understanding how social anxiety affects people requires this information. Avoiding social situations for fear of criticism can make it harder to build and maintain relationships, succeed in school or work, and live a fulfilling life.The median response of 75% indicates that half of students with social anxiety would take measures to avoid criticism, while the other half would not.The interquartile range (IQR) is 25%, with 50% of responses falling between 50-75%.Outliers are non-IQR responses. The box plot has two outliers, both above 90%. Thus, a small percentage of socially anxious students fear criticism very much.The box plot shows that more socially anxious students fear criticism severely than mildly due to the rightward skewness of the response distribution.Interventions can help socially anxious students manage their fear of criticism. Therapists can help students recognise and change their negative views of criticism and develop healthy coping strategies.

12) PHYSIOLOGICAL SYMPTOMS OF SOCIAL ANXIETY

Figure 16 shows the ridge plot of Physiological Symptoms ''Heart palpitations bother me when I am around people''. The ridge plot shows that as social phobia worsens, more students report that heart palpitations make them uncomfortable around people. Compared to 10% of students with moderate social phobia, 20% with mild, 30% with severe, and 40% with very severe, only 5% of students without social phobia experience heart palpitations in social situations.This knowledge can help social anxiety students control heart palpitations and stop avoiding.Palpitations become more frequent as social anxiety worsens.Heart palpitations are depressing and disrupt social life.

13) FEAR OF PERFORMANCE EVALUATION

Figure 17 shows Performance Fear. In the violin plot, more students report being afraid to do things in front of others. The violin plot's size shows data spread. Data spreads across the
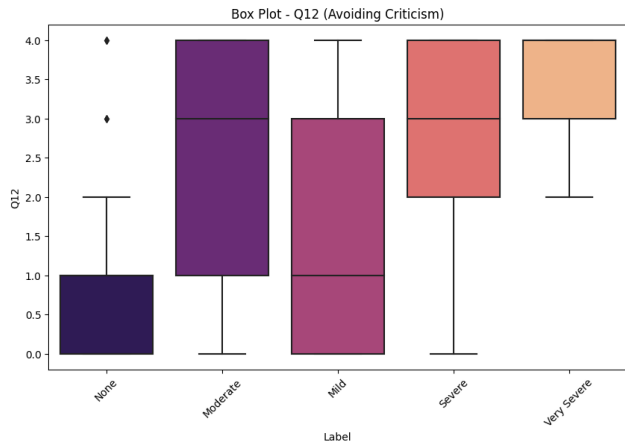
FIGURE 15. Extreme responses to critique - question 12 patterns.

FIGURE 16. Physiological symptoms - question 13 analysis on heart palpitations.

FIGURE 17. Fear of performance evaluation - question 14 response distribution.

violin plot. This suggests socially anxious students have more responses.Extremely anxious students have a wider violin plot than non-anxious students. The fact that some students are extremely afraid to do anything when they think someone is watching and others are only mildly afraid suggests that students with extremely severe social phobia have a wider range of responses.Lower self-esteem and confidence are more common.They're more likely to doubt themselves and their abilities.They care more about others' opinions and assessments. They avoid social situations where they may be noticed.They feel more anxious and distressed socially.

14) EXAMINING FEAR OF EMBARRASSMENT

"I am afraid of doing things when people might be watching" is shown in a box plot Figure 18. Socially phobic students may have a greater range of public performance anxiety. The box plot shows that socially anxious students are more likely to be afraid to act in public. The boxes' sizes also suggest that severe social phobia increases the fear of acting in public while others are watching. Outliers suggest a small percentage of students have social phobia and are afraid to act in public. Students with severe social anxiety are more likely to fear public speaking. The box for students with extreme social anxiety is the largest, asymmetrical, and has a longer right tail. Students with mild social phobia have a wider range of public anxiety than those without. The mild social anxiety box is larger than the box for students without social anxiety, suggesting this.A minority of students have social phobia, which makes them afraid to act in public. The boxes for mild, severe, and extremely severe social phobia students have outliers, indicating validity.

15) SOCIAL ANXIETY IN POWER DYNAMICS

Figure 19 shows Power Dynamics Social Anxiety. Half of students with severe social anxiety avoid speaking to those in positions of power, while only 5% of those without social anxiety do so.Size of box indicates range of answers for each social phobia label. Box size increases response range. This suggests that socially anxious students may avoid
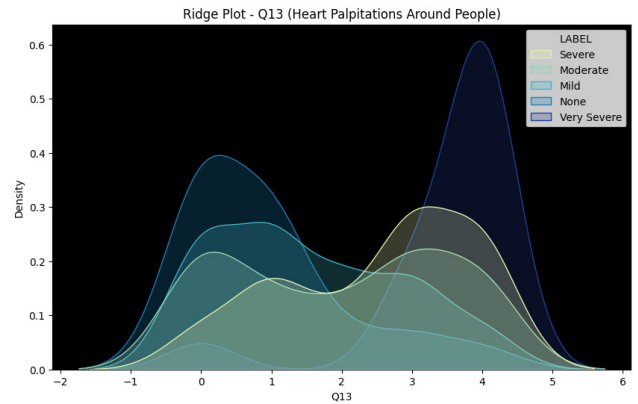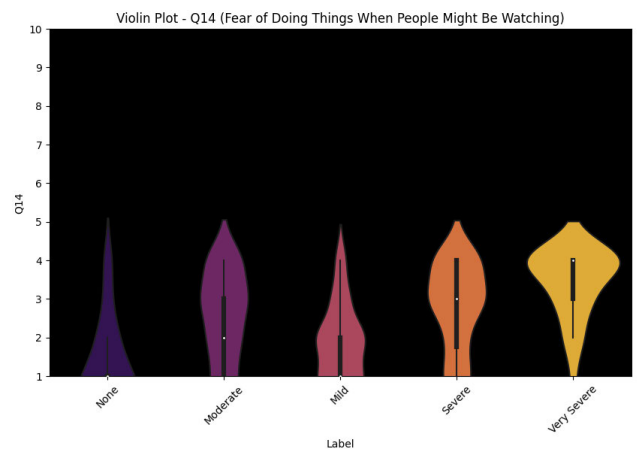
communicating with leaders to a greater extent. Outliers of social anxiety may avoid speaking to those in power more or less.The box plot suggests that social anxiety is characterised by avoiding leaders, which worsens with severity.For each social phobia label, the median percentage of students who avoid talking to authority increases with severity. Half of students with severe social anxiety avoid speaking to those in power, while only 5% of those without social anxiety do so.

16) EXPLORING PHYSICAL MANIFESTATIONS OF ANXIETY

Figure 20 shows anxiety's physical symptoms. "Trembling or shaking in front of others is distressing to me" says.The ridge plot shows that social phobia label responses are right-skewed. Thus, more socially anxious students say trembling or shaking in front of others causes them great distress than minor distress.The ridge plot shows a slight overlap in social phobia label response distributions. Some students with mild social anxiety may find it upsetting to tremble or shake in public, and vice versa. Trembling in public is a common sign of social phobia. The ridge plot shows that over half of socially anxious students find it upsetting to tremble or shake in public.Social phobia labels have a slight overlap
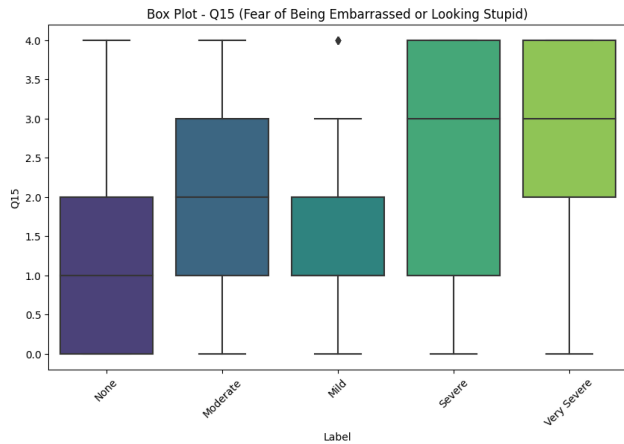
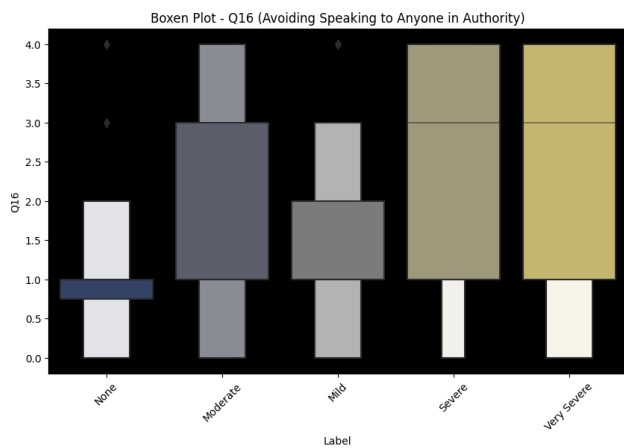FIGURE 18. Fear of embarrassment analysis - question 15 patterns.

FIGURE 19. Social anxiety in power dynamics - question 16 analysis.

in response distributions. Some students with mild social anxiety may find it as upsetting to tremble or shake in front of people as those with severe anxiety, and interventions can help them cope and stop avoiding.

E. MAPPING SOCIAL PHOBIA CHARACTERISTICS: EXPLORING INTERCONNECTIONS THROUGH CORRELATION MATRIX

The figure 21 shows 17 social anxiety questions' correlation matrix. A dataset's correlation matrix shows each pair of variables' correlation coefficients. Correlation coefficient measures linear relationship strength and direction between two variables.Social anxiety question pairs are correlated in the diagram. Questions 1 and 2 correlate 0.24. This suggests a positive correlation between questions. Thus, those who do well on question 1 will likely do well on question 2, and vice versa.The Correlation Matrix of 17 Social Phobia Characteristics is in Figure 22. Figure correlation coefficients are −0.8 to 1.0. A 1.0 positive correlation coefficient indi- cates perfect relationship between variables. Two variables are inversely related with a perfect negative correlation (−1.0). A 0.0 correlation coefficient means the variables are uncorrelated.For each social anxiety question, the diagram's
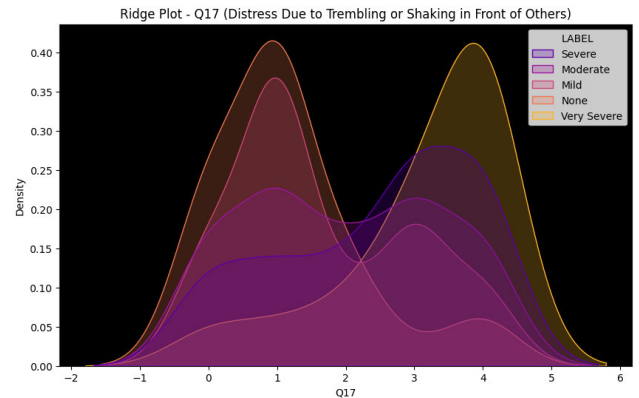

FIGURE 20. Physical manifestations of anxiety - question 17 distribution.

correlation coefficients are positive. This suggests that those who do well on one social suitability question will do well on subsequent social phobia questions.Questions with similar content correlate best. Question 1 The diagram's correlation coefficients are all positive, indicating a positive correlation between social anxiety questions. This suggests that those who score well on one social phobia question are more likely to score well on others. Answering "I feel anxious when I am around other people" has a 0.24 correlation coefficient. These two questions can measure social anxiety, the same construct.Some questions with less content similarity have moderate correlations. Question 1 ("I avoid social situations because I am afraid of being humiliated") and Question 7 ("I feel like everyone is judging me") have 0.16 correlations. This suggests that the two questions measure different aspects of social anxiety but are related.Overall, the correlation matrix summarises the 17 social anxiety questions' relationships. It shows that all questions are positively correlated and that questions with similar content are most correlated. The correlation matrix helps researchers understand the complex network of social phobia questions. This knowledge helps improve measurement tools, identify duplicate or overlapping items, and accurately assess student social anxiety.

Several significant points can be gathered from the diagram.

F. EXPLORING CUMULATIVE RESPONSES ACROSS MULTIPLE QUESTIONS

Figure 22 shows The heatmap shows the cumulative responses for each social phobia label, providing a complete picture of students' experiences across 17 questions.These relationships' direction and strength are shown by the heatmap's colour gradient. Intense red areas along the rows indicate a strong positive correlation between increasing social anxiety severity and decreasing social anxiety scores. Higher test scores suggest lower social anxiety.A moderate positive correlation (darker yellow) means that a lower level of social anxiety is linked to higher scores on specific social anxiety questions.Weak Positive Correlation
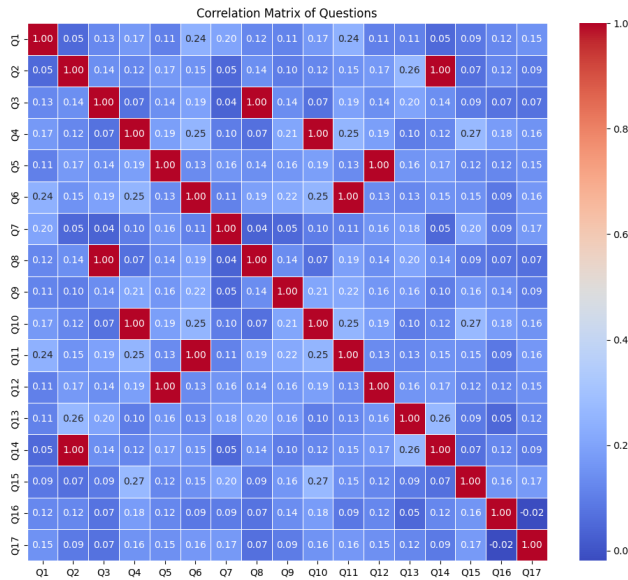
FIGURE 21. Correlation matrix depicting the interrelationships among the 17 social phobia characteristics.

FIGURE 22. The heatmap visually represents the cumulative responses for each social phobia label, offering a comprehensive overview of the students' experiences across the spectrum of 17 questions.

(Green): Areas lighter in yellow or green indicate a weaker positive correlation, indicating a less significant relationship between social anxiety severity and question scores.Moderate Negative Correlation (Blue): Light blue hues indicate a moderate negative correlation, implying a slight correlation between severity and lower social anxiety scores.Robust negative correlation (Darker Blue): Areas with a dark blue hue indicate a strong negative correlation, indicating that slightly higher scores on certain items are linked to milder social anxiety.White areas indicate that there is no significant correlation between mean scores on a set of questions and social anxiety severity.The heatmap quantifies the relationship between social anxiety severity and mean scores on specific questions. Lower scores on avoidance, social anxiety, and negative self-perception indicate less severe social phobia, while higher scores indicate more severe phobia.

G. IDENTIFYING SUBGROUPS: CLUSTERING ANALYSIS OF SOCIAL PHOBIA CHARACTERISTICS

Table 2 shows a cluster-wise analysis of 17 question responses on social anxiety traits. Mean values for each question within clusters provide an in-depth comprehension of subgroup characteristics. Little Scholars School students' social anxiety patterns can be compared in the table's overall average.Cluster analysis shows five clusters corresponding to different social anxiety levels. These clusters help explain social phobia's range from Very Severe to None. According to Moderate Social Phobia prevalence, Cluster 3 has a high rate of moderate severity. Clusters 1 and 2, which represent Very Severe and Severe Social Phobia, respectively, make up a large minority, demonstrating severe signs and symptoms. Clusters 4 and 5—Mild Social Phobia and None Social Phobia—show the range of symptoms. These
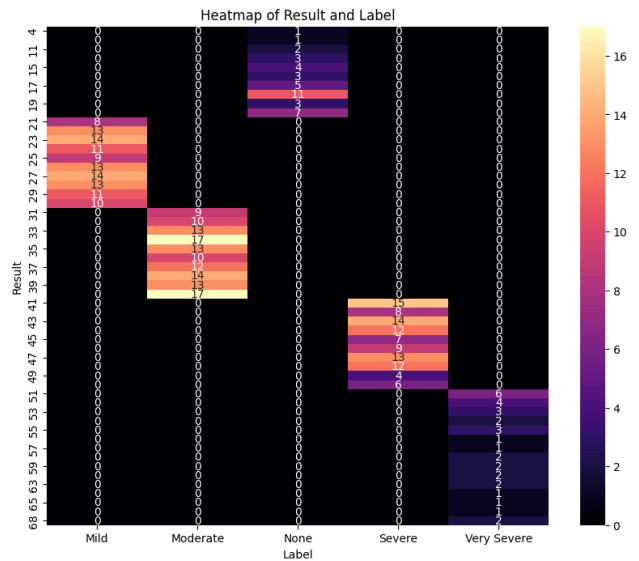
findings suggest that treatment should be tailored, that social phobia is heterogeneous, and that severity factors should be considered. Due to the sample's specificity and clustering algorithms' sensitivity, these findings must be extended cautiously. Overall, the cluster analysis reveals the complex distribution of social anxiety severity, which informs future research and clinical practise. Figure 23 shows cluster analysis uses 17 question responses to identify Little Scholars School student subgroups. Using unsupervised learning algorithms like k-means clustering, patterns of similarities and differences emerge, revealing social phobia subgroup characteristics.Cluster0: Extreme Social Fear This cluster has high mean scores for all questions, especially Q4 (3.47) and Q11 (3.71), indicating a long history of severe social anxiety.People in this cluster often have low self-esteem (Q9 and Q12), avoid social situations (Q4 and Q11), and have anxiety (Q6 and Q15).The average score of 3.00 and result of 50.82% indicate severe social phobia in this cluster.The variable's high standard deviation (4.43), suggesting significant severity variation.None to Mild Social Phobia: Cluster 1. Cluster 1 is defined by low mean scores on most questions, especially Q4 (0.74) and Q10 (0.74).This cluster has few avoidance behaviours (Q4 and Q10), low anxiety (Q6 and Q15), and positive self-image (Q9 and Q12).The average result (22.68) and score (1.33) in this cluster indicate lower social phobia.The variable's standard deviation of 1.76 indicates less severity variation.Cluster 2: Mild Social Fear Cluster 2, with moderate mean scores on Q4 (2.71) and Q12 (3.08), is mixed.This cluster may have mixed self-perceptions (Q9 and Q12), selectively avoid social situations (Q4 and Q11), and moderate anxiety (Q6 and Q15).Average score of 2.18 and result of 37.00 indicate moderate social anxiety.Standard deviation (3.15) of the label variable indicates severity variation.Cluster 3: Complicated
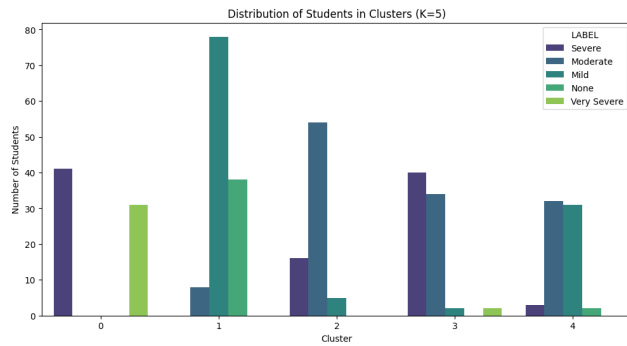
FIGURE 23. shows the cluster analysis aims to identify distinct subgroups within the Little Scholars School student population based on their responses to the 17 questions. By employing unsupervised learning algorithms like k-means clustering, patterns of similarities and differences emerge, allowing for a nuanced understanding of social phobia characteristics within specific subgroups.

Social Fears Q3, Q6, Q8, and Q11 have high mean scores, while others have low mean scores. Avoidance (Q11), anxiety (Q6 and Q15), and conflicting self-perceptions (Q9 and Q12) may characterise this cluster. The average score of 2.41 and result of 41.01 show a wide range of social phobia symptoms. The standard deviation of the 'label' variable (3.54) shows severity variation within this cluster. Cluster 4: Mild Social Fear with Particulars The moderate mean score and higher Q4 (3.00) and Q11 (3.03) scores distinguish Cluster 4. This group may have mixed self-perceptions (Q9 and Q12), avoidance (Q4 and Q11), and moderate anxiety (Q6 and Q15). The average score of 1.82 and result of 30.97 indicate moderate social anxiety with specific traits. The 'label' variable's standard deviation (2.53), indicates severity variation.

V. DISCUSSION

This research paper explores the identification of social phobia in high school students within the LSMS School atmosphere. It accomplishes this through employing a multimodal analytical approach to reveal the various social phobic traits that are common in this group. By implementing a range of plots, correlation analyses, clustering techniques, and machine learning methodologies, the research aims to furnish a thorough comprehension of the diverse experiences of social phobia that these students encounter. The distribution of answers to the 17 questions is shown visually through the use of several plots, such as box plots, ridge plots, and violin plots. This allows for a comparison analysis across various social phobia labels. Notably, these plots show how distress is increasing as social phobia severity rises and offer insights into the distribution, form, and outliers of the data. Our study confirmed the measurement model of the constructs under investigation and clarified the underlying factor structure based on the findings from the exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Three unique factors were found in the robust factor structure that the EFA revealed: High loadings from items Q5, Q6, Q7, Q11, and Q12 define Factor 1; items Q4, Q10, and Q16 define Factor

2; and items Q3, Q8, Q9, and Q13 define Factor 3. In addition, the EFA showed a distinct scree plot and eigenvalues greater than one, indicating a satisfactory model fit. The CFA then verified the suitability of the proposed measurement model, as shown by positive fit indices ($X^2 = 127.84$, $CFI = 0.95$, $TLI = 0.93$, $RMSEA = 0.07$, $SRMR = 0.04$) Strong correlations between observed variables and latent constructs were indicated by the significant and substantial standardised factor loadings. Furthermore, residual analyses showed very small residual covariances, confirming the suitability of the model. The validity and reliability of our measurement model are empirically supported by these findings, which boosts confidence in the interpretation of study results. In a high school context where social interactions are complex, visual aids play a critical role in capturing the minute details of social anxiety experiences. An essential part of the study involves correlation analyses, which reveal complex connections among the 17 questions and provide insight into possible trends and dependencies. Examining the correlations between various variables enables the identification of relationships that might not be immediately obvious, leading to a more comprehensive comprehension of the complex nature of social anxiety. In the high school setting, where social interactions have a substantial impact on students' everyday lives and well-being, this aspect is especially pertinent. Using clustering techniques improves the research's ability to identify specific subgroups among the student population at Little Scholars School. The study looks for patterns of similarity or difference in the 17 questions that students answered, using unsupervised learning algorithms such as k-means clustering. This method acknowledges the diversity within the high school class and provides personalised insights into the traits of social anxiety that might be more common in particular groups. To extract latent features and characteristics associated with each of the 17 questions, machine learning techniques are essential to extract the accurate insight. Machine learning is frequently favoured over conventional statistical techniques for identifying social phobia using questionnaires such as the Social Phobia Inventory (SPIN) due to its numerous advantages. Machine learning algorithms have the capability to process high-dimensional data obtained from questionnaires such as the SPIN. They can effectively identify important features and patterns that are linked to social phobia. Furthermore, they demonstrate exceptional proficiency in capturing non-linear associations between questionnaire responses and the occurrence or intensity of social anxiety symptoms, a task that conventional methods may find challenging. Furthermore, machine learning models exhibit a remarkable degree of flexibility and adaptability, enabling researchers to analyse SPIN data in its original, unprocessed state without the need for extensive preprocessing. Moreover, machine learning techniques facilitate the process of selecting relevant features and ranking their importance, thereby enhancing the accuracy and interpretability of predictions. Additionally, these models are capable of managing imbalanced datasets

TABLE 2. Social anxiety characteristics - cluster-wise analysis.

	CLUSTER 0	CLUSTER 1	CLUSTER 2	CLUSTER 3	CLUSTER 4
STD	10.444	11.808	10.920	10.769	10.602
AGE	14.597	15.000	15.320	13.884	14.750
Q1	2.788	1.408	1.693	2.166	1.514
Q2	2.583	1.298	2.826	2.833	0.926
Q3	2.875	1.776	1.866	3.269	0.955
Q4	3.472	0.744	2.706	1.423	3.000
Q5	3.169	1.344	3.080	2.141	1.602
Q6	3.708	0.952	0.824	3.358	3.029
Q7	2.541	1.600	2.093	2.012	1.83
Q8	2.875	1.792	1.866	3.269	0.95
Q9	3.211	1.728	2.173	2.576	2.058
Q10	3.472	0.7440	2.706	1.423	3.000
Q11	3.708	0.952	0.824	3.358	3.029
Q12	3.169	1.344	3.080	2.141	1.602
Q13	2.861	1.512	2.280	2.333	1.294
Q14	2.583	1.298	2.826	2.833	0.926
Q15	2.873	1.344	2.2000	1.705	1.882
Q16	2.33	1.320	2.133	1.974	1.45
Q17	2.805	1.544	1.840	2.192	1.985
RESULT	50.819	22.680	37.000	41.012	30.970
LABEL	4.430	1.758	3.146	3.538	2.529
AVG SCORE	3.002	1.334	2.180	2.412	1.824

that are frequently encountered in the identification of social phobia. Furthermore, they exhibit strong generalisation abilities when applied to new populations, thereby enhancing the effectiveness of assessment and intervention strategies for individuals with social anxiety disorders. This machine learning-driven investigation in the context ofLSMS School makes it possible to pinpoint important predictors and speeds up the creation of models that could forecast distress levels in particular social contexts.In the context of LSMS School, the research's analytical framework helps to identify social anxiety in high school students and reveals the unique social phobic traits that are present in this particular learning environment. By combining a variety of analytical methods, the holistic approach seeks to offer complex insights into the experience of social phobia, enabling focused interventions that correspond to the various needs of students in this special setting and a thorough knowledge is necessary to create a safe learning environment and put into practise practical methods that lessen the negative effects of social anxiety on the wellbeing of LSMS high school students.

VI. CONCLUSION

The in-depth investigation of social anxiety in LSMS students revealed a complex landscape of social phobia characteristics and intensities. We succeeded in displaying the complex pattern of the 17 questions' answers using violin plots, box plots, and ridge plots. The images show how social anxiety severity increases distress. After conducting correlation analyses, we discovered complex patterns and dependencies in the data and hidden connections between the 17 questions. In high school, social interactions greatly affect students' daily lives and emotional health, making this deeper understanding significant. Clustering has helped us identify social phobia-related subgroups in the student

community. This comprehensive approach acknowledges group diversity, enabling customized interventions tailored to specific subgroup needs. Machine learning has enabled predictive modeling and improved our understanding of distress factors. This machine learning-based study shows our commitment to using cutting-edge methods to understand high school students' social anxiety.Our study defines social anxiety and identifies learning environment-specific social phobia traits in LSMS School. A positive learning environment in schools requires thorough comprehension using multiple analytical methods. Our study gave educators and stakeholders the knowledge to implement effective strategies to reduce social anxiety's negative effects on LSMS School's mental health. We develop solutions that exceed the general approach by integrating careful data analysis and a compassionate understanding of high school students' unique challenges. This study alters educational practices beyond educational institutions. It also encourages acceptability and psychological well-being in future learners. Psychologists assess and design interventions, educators perceive classroom dynamics, and technologists deliver innovative interventions, enabling collaborative efforts to implement and improve student social phobia interventions. Interdisciplinary collaboration can create and improve comprehensive intervention programs to address social phobia's multiple aspects, improving social and academic outcomes.

VII. FUTURE DIRECTIONS

This research provides new hope for the future by positing that therapeutic interventions utilizing VR and AR environments may help students who have been diagnosed with social phobia. Using the in-depth data collected from the survey, the suggested approach comprises coming up with realistic scenarios that reflect the students' identified anxieties, along with questions that describe each scenario. Particular components of social phobia, like introversion, shyness around attention, or difficulty interacting in small groups, are targeted by these meticulously crafted scenarios. Providing a controlled and gradual exposure that aids in elimination and therapeutic advancement is the aim. The effectiveness and adaptability of these strategies are ensured through real-time monitoring and feedback mechanisms, and they are tailored to each individual. It is becoming more and more important for experts in psychology, education, and technology to work together as this research transitions from theoretical domains to practical applications. High school students suffering from social anxiety may find relief through VR and AR therapy, according to an interdisciplinary team that is quickly opening doors to both experimental and ongoing studies to investigate the assertion. High school students' mental health and wellness could be revolutionized by this innovative interpretation, which not only corresponds to the evolving field of therapeutic interventions but also introduces a new age of technologically advanced support networks. Further research should examine how cultural norms, practices, and beliefs affect diverse

student populations at schools and how they affect social anxiety. Studying how cultural backgrounds, intercultural interactions, adjustment, and perceived social support affect social anxiety outcomes provides insights. Accounting for cultural differences allows for the creation of culturally sensitive interventions that meet the needs of students from diverse cultural backgrounds, creating more inclusive and effective educational support networks.

REFERENCES

[1] T. Furmark, "Social phobia: Overview of community surveys," *Acta Psychiatrica Scandinavica*, vol. 105, no. 2, pp. 84–93, Feb. 2002, doi: 10.1034/j.1600-0447.2002.1r103.x.

[2] R. P. Mattick and J. C. Clarke, "Development and validation of measures of social phobia scrutiny fear and social interaction anxiety," *Behav. Res. Therapy*, vol. 36, no. 4, pp. 455–470, Apr. 1998, doi: 10.1016/s0005-7967.

[3] A. S. Morrison and R. G. Heimberg, "Social anxiety and social anxiety disorder," *Annu. Rev. Clin. Psychol.*, vol. 9, no. 1, pp. 249–274, Mar. 2013, doi: 10.1146/annurev-clinpsy-050212-185631.

[4] K. N. T. Månsson, A. Frick, C.-J. Boraxbekk, A. F. Marquand, S. C. R. Williams, P. Carlbring, G. Andersson, and T. Furmark, "Predicting long-term outcome of internet-delivered cognitive behavior therapy for social anxiety disorder using fMRI and support vector machine learning," *Transl. Psychiatry*, vol. 5, no. 3, p. e530, Mar. 2015, doi: 10.1038/tp.2015.22.

[5] I. L. Kampmann, P. M. G. Emmelkamp, and N. Morina, "Self-report questionnaires, behavioral assessment tasks, and an implicit behavior measure: Do they predict social anxiety in everyday life?" *PeerJ*, vol. 6, Aug. 2018, Art. no. e5441, doi: 10.7717/peerj.5441.

[6] S. M. Turner, D. C. Beidel, and R. M. Townsley, "Social phobia: Relationship to shyness," *Behav. Res. Therapy*, vol. 28, no. 6, pp. 497–505, 1990, doi: 10.1016/0005-7967(90)90136-7.

[7] M. G. Newman, K. E. Kachin, A. R. Zuellig, M. J. Constantino, and L. Cashman-Mcgrath, "The social phobia diagnostic questionnaire: Preliminary validation of a new self-report diagnostic measure of social phobia," *Psychol. Med.*, vol. 33, no. 4, pp. 623–635, May 2003, doi: 10.1017/s0033291703007669.

[8] K. Ranta, R. Kaltiala-Heino, P. Rantanen, M. T. Tuomisto, and M. Marttunen, "Screening social phobia in adolescents from general population: The validity of the social phobia inventory (SPIN) against a clinical interview," *Eur. Psychiatry*, vol. 22, no. 4, pp. 244–251, May 2007, doi: 10.1016/j.eurpsy.2006.12.002.

[9] P. M. McEvoy and P. Kingsep, "The post-event processing questionnaire in a clinical sample with social phobia," *Behaviour Res. Therapy*, vol. 44, no. 11, pp. 1689–1697, Nov. 2006, doi: 10.1016/j.brat.2005.12.005.

[10] E. Tuyishimire, W. Mabuto, P. Gatabazi, and S. Bayisingize, "Detecting learning patterns in tertiary education using K-means clustering," *Information*, vol. 13, no. 2, p. 94, Feb. 2022, doi: 10.3390/info13020094.

[11] Y. Chen, X. Zhang, L. Lu, Y. Wang, J. Liu, L. Qin, L. Ye, J. Zhu, B.-C. Shia, and M.-C. Chen, "Machine learning methods to identify predictors of psychological distress," *Processes*, vol. 10, no. 5, p. 1030, May 2022, doi: 10.3390/pr10051030.

[12] K. Aafjes-van Doorn, C. Kamsteeg, J. Bate, and M. Aafjes, "A scoping review of machine learning in psychotherapy research," *Psychotherapy Res.*, vol. 31, no. 1, pp. 92–116, Aug. 2020, doi: 10.1080/10503307.2020.1808729.

[13] M. P. Ewbank, R. Cummins, V. Tablan, S. Bateup, A. Catarino, A. J. Martin, and A. D. Blackwell, "Quantifying the association between psychotherapy content and clinical outcomes using deep learning," *JAMA Psychiatry*, vol. 77, no. 1, p. 35, Jan. 2020, doi: 10.1001/jamapsychiatry.2019.2664.

[14] B. Bennemann, B. Schwartz, J. Giesemann, and W. Lutz, "Predicting patients who will drop out of out-patient psychotherapy using machine learning algorithms," *Brit. J. Psychiatry*, vol. 220, no. 4, pp. 192–201, Feb. 2022, doi: 10.1192/bjp.2022.17.

[15] I. M. Aderka, A. Kauffmann, J. G. Shalom, C. Beard, and T. Björgvinsson, "Using machine-learning to predict sudden gains in treatment for major depressive disorder," *Behav. Res. Therapy*, vol. 144, Sep. 2021, Art. no. 103929, doi: 10.1016/j.brat.2021.103929.

[16] N. Altrabsheh, M. Cocea, and S. Fallahkhair, "Predicting students emotions using machine learning techniques," in *Artificial Intelligence in Education*. Springer, Jan. 2015, pp. 537–540, doi: 10.1007/978-3-319-19773-9_56.

[17] M. G. S. Ortega, L.-F. Rodríguez, and J. O. Gutierrez-Garcia, "Towards emotion recognition from contextual information using machine learning," *J. Ambient Intell. Humanized Comput.*, vol. 11, no. 8, pp. 3187–3207, Sep. 2019, doi: 10.1007/s12652-019-01485-x.

[18] A. Hassouneh, A. M. Mutawa, and M. Murugappan, "Development of a real-time emotion recognition system using facial expressions and EEG based on machine learning and deep neural network methods," *Informat. Med. Unlocked*, vol. 20, Jun. 2020, Art. no. 100372, doi: 10.1016/j.imu.2020.100372.

[19] J. Boettcher, P. Carlbring, B. Renneberg, and T. Berger, "Internet-based interventions for social anxiety disorder—An overview," *Verhaltensthera-pie*, vol. 23, no. 3, pp. 160–168, 2013, doi: 10.1159/000354747.

[20] B. Hu, Y. Mao, and K. J. Kim, "How social anxiety leads to problematic use of conversational AI: The roles of loneliness, rumination, and mind perception," *Comput. Hum. Behav.*, vol. 145, Aug. 2023, Art. no. 107760, doi: 10.1016/j.chb.2023.107760.

[21] A. L. Kidd, "Loneliness and love," *Screen Bodies*, vol. 7, no. 2, pp. 89–108, Dec. 2022, doi: 10.3167/screen.2022.070207.

[22] S. Rajendran, S. Chamundeswari, and A. A. Sinha, "Predicting the academic performance of middle- and high-school students using machine learning algorithms," *Social Sci. Humanities Open*, vol. 6, no. 1, 2022, Art. no. 100357, doi: 10.1016/j.ssaho.2022.100357.

[23] M. Yağcı, "Educational data mining: Prediction of students' academic performance using machine learning algorithms," *Smart Learn. Environ.*, vol. 9, no. 1, pp. 1–19, Mar. 2022, doi: 10.1186/s40561-022-00192-z.

[24] S. Rajendran, "Predicting factors impacting student academic performance using machine learning algorithms," *SSRN Electron. J.*, vol. 10, no. 3, pp. 637–655, 2021, doi: 10.2139/ssrn.3898302.

[25] A. Ahmed, S. Aziz, C. T. Toro, M. Alzubaidi, S. Irshaidat, H. A. Serhan, A. A. Abd-Alrazaq, and M. Househ, "Machine learning models to detect anxiety and depression through social media: A scoping review," *Comput. Methods Programs Biomed. Update*, vol. 2, Sep. 2022, Art. no. 100066, doi: 10.1016/j.cmpbup.2022.100066.

[26] B. Keles, N. McCrae, and A. Grealish, "A systematic review: The influence of social media on depression, anxiety and psychological distress in adolescents," *Int. J. Adolescence Youth*, vol. 25, no. 1, pp. 79–93, Mar. 2019, doi: 10.1080/02673843.2019.1590851.

[27] K. L. H. Carpenter, P. Sprechmann, R. Calderbank, G. Sapiro, and H. L. Egger, "Quantifying risk for anxiety disorders in preschool children: A machine learning approach," *PLoS ONE*, vol. 11, no. 11, Nov. 2016, Art. no. e0165524, doi: 10.1371/journal.pone.0165524.

[28] M. Li, "Data mining algorithm for college students' mental health questionnaire based on semisupervised deep learning method," *Sci. Program.*, vol. 2022, pp. 1–10, Aug. 2022, doi: 10.1155/2022/7113312.

[29] G. Russell and P. Topham, "The impact of social anxiety on student learning and well-being in higher education," *J. Mental Health*, vol. 21, no. 4, pp. 375–385, Jul. 2012, doi: 10.3109/09638237.2012.694505.

[30] J. Pinto-Gouveia, M. I. Cunha, and M. do Cu Salvador, "Assessment of social phobia by self-report questionnaires: The social interaction and performance anxiety and avoidance scale and the social phobia safety behaviours scale," *Behavioural Cognit. Psychotherapy*, vol. 31, no. 3, pp. 291–311, Jul. 2003, doi: 10.1017/s1352465803003059.

[31] M. Hajure and Z. Abdu, "Social phobia and its impact on quality of life among regular undergraduate students of Mettu University, Mettu, Ethiopia," *Adolescent Health, Med. Therapeutics*, vol. 11, pp. 79–87, Jun. 2020, doi: 10.2147/AHMT.S254002.

[32] E. G. Pintelas, T. Kotsilieris, I. E. Livieris, and P. Pintelas, "A review of machine learning prediction methods for anxiety disorders," in *Proc. 8th Int. Conf. Softw. Develop. Technol. Enhancing Accessibility Fighting Info-Exclusion*, Jun. 2018, pp. 8–15, doi: 10.1145/3218585.3218587.

[33] D. Newton, A. Day, C. Gillies, and E. Fernandez, "A review of evidence-based evaluation of measures for assessing social and emotional well-being in indigenous Australians," *Austral. Psycholog.*, vol. 50, no. 1, pp. 40–50, Feb. 2015, doi: 10.1111/ap.12064.

[34] K. A. Archbell and R. J. Coplan, "Too anxious to talk: Social anxiety, academic communication, and students' experiences in higher education," *J. Emotional Behav. Disorders*, vol. 30, no. 4, pp. 273–286, Dec. 2021, doi: 10.1177/10634266211060079.

[35] C. A. Brook and T. Willoughby, "The social ties that bind: Social anxiety and academic achievement across the university years," *J. Youth Adolescence*, vol. 44, no. 5, pp. 1139–1152, Feb. 2015, doi: 10.1007/s10964-015-0262-8.

[36] S. G. Hofmann, "Cognitive factors that maintain social anxiety disorder: A comprehensive model and its treatment implications," *Cognit. Behav. Therapy*, vol. 36, no. 4, pp. 193–209, Dec. 2007, doi: 10.1080/16506070701421313.

[37] A. Hamad, "Prevalence of social phobia among high school students in Erbil, Kurdistan region," *Zanco J. Med. Sci.*, vol. 20, no. 3, pp. 1497–1504, Dec. 2016, doi: 10.15218/zjms.2016.0050.

[38] O. S. Murad, "Social anxiety in relation to self-esteem among university students in Jordan," *Int. Educ. Stud.*, vol. 13, no. 2, pp. 96–103, 2020. [Online]. Available: https://eric.ed.gov/?id=EJ1241876

[39] R. G. Heimberg, G. P. Mueller, C. S. Holt, D. A. Hope, and M. R. Liebowitz, "Assessment of anxiety in social interaction and being observed by others: The social interaction anxiety scale and the social phobia scale," *Behav. Therapy*, vol. 23, no. 1, pp. 53–73, 1992, doi: 10.1016/s0005-7894(05)80308-9.

[40] O. Ojajuni, "Predicting student academic performance using machine learning," in *Proc. Int. Conf. Comput. Sci. Its Appl.*, 2021, pp. 481–491, doi: 10.1007/978-3-030-87013-3_36.

[41] B.-H. Kim, M.-K. Kim, H.-J. Jo, and J.-J. Kim, "Predicting social anxiety in young adults with machine learning of resting-state brain functional radiomic features," *Sci. Reports*, vol. 12, no. 1, pp. 1–11, Aug. 2022, doi: 10.1038/s41598-022-17769-w.

[42] A. V. Chavanne, "Anxiety onset in adolescents: A machine-learning prediction," *Mol. Psychiatry*, vol. 28, no. 2, pp. 639–646, Dec. 2022, doi: 10.1038/s41380-022-01840-z.

[43] B. Ejaz, A. Muazzam, A. Anjum, G. Pollock, and R. Nawaz, "Measuring the scale and scope of social anxiety among students in Pakistani higher education institutions: An alternative social anxiety scale," *Sustainability*, vol. 12, no. 6, p. 2164, Mar. 2020, doi: 10.3390/su12062164.

[44] P. H. Fisher, C. Masia-Warner, and R. G. Klein, "Skills for social and academic success: A school-based intervention for social anxiety disorder in adolescents," *Clin. Child Family Psychol. Rev.*, vol. 7, no. 4, pp. 241–249, Dec. 2004, doi: 10.1007/s10567-004-6088-7.

[45] M. Eryilmaz and C. Cigdemoglu, "Individual flipped learning and cooperative flipped learning: Their effects on students' performance, social, and computer anxiety," *Interact. Learn. Environ.*, vol. 27, no. 4, pp. 432–442, Sep. 2018, doi: 10.1080/10494820.2018.1522652.

[46] C. Verma, Z. Ills, and D. Kumar, "An investigation of novel features for predicting student happiness in hybrid learning platformsAn exploration using experiments on trace data," *Int. J. Inf. Manage. Data Insights*, vol. 4, no. 1, 2024, Art. no. 100219.

[47] C. Verma, V. Stoffov, Z. Ills, and D. Kumar, "Toward prediction of students guardian in the Secondary Schools for the real time," in *Proc. Int. Conf. Recent Innov. Comput.* Cham, Switzerland: Springer, 2021, pp. 755–765.

M. ABINAYA received the B.Tech. degree from the Sairam Institute of Technology, in 2017, and the M.Tech. degree from SASTRA Deemed to be University, in 2019. She is currently pursuing the Ph.D. degree with the Department of Data Science and Business Systems, SRM Institute of Science and Technology, India, through the Visvesvaraya Ph.D. Scheme for Electronics and Information Technology, which is funded by the Ministry of Electronics and Information Technology. Her research interests include augmented reality, virtual reality, machine learning, and mixed reality.

G. VADIVU received the B.E., M.Tech., and Ph.D. degrees. With more than 25 years of academic experience. She is currently a Professor with the Department of Data Science and Business Systems, SRM University. She also has a number of publications and an active researcher. She has completed numerous certifications, including those from NVIDIA, Udemy, Coursera, NPTEL, and Oracle. Her research interests include data analytics, machine learning, data mining, and semantic web. She is also a yearly member of the IET, ISC, ACM-W, CSI, and ISC. In 2012, she was awarded a research grant from Dalhousie University, Canada.

• • •