



Using machine learning techniques to study of stress, depression, and academic performance of grade 12th students

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Abstract

The objectives of this research were 1) to study the problems of stress and depression among Grade 12 students; 2) to investigate the machine learning technique in analyzing and predicting stress, depression, and academic performance among Grade 12 students; and 3) to evaluate the stress and depression prediction platform. Students from schools in the Secondary Educational Service Areas of Nakhon Sawan, Uthai Thani, Chainat, and Pichit in Thailand comprised the sampling group, which the researchers recruited through simple random sampling. A total of 510 students volunteered to participate in the questionnaire, while 117 students served as the group for the evaluation platform. The researcher employed a total of three assessments: 1) the Stress Assessment Scale (SPST-20), 2) the Depression Assessment Form 9 Questions (9Q), and 3) the Death Assessment Form (8Q) to gather data and develop the platform. The data analytics process incorporates all assessment results, comparing five techniques to yield the most accurate results. The article presents the research results, which will guide the development of a system and tools for future student monitoring in schools.

Keywords: Stress, Depression, Data analytics, Machine learning techniques, Platform, Grade 12th students, Thailand.

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Contribution of this paper to the literature

Students in Grade 12 are required to take university entrance exams, and teachers must take care of their students if they are mentally ill or stressed. This paper outlines the system for screening and supervising students. Teachers can use the data to analyze and organize activities, whether teaching or recreation, to alleviate students' symptoms.

1. Introduction

Adolescence is the age that marks the juncture of childhood development and adulthood, requiring adaptation in many aspects at the same time. This is an age where numerous challenges will arise. Successful adaptation will help adolescents develop themselves. At the same time, stress affects adolescent development, causing children to be less focused on school, have aggressive behavior, lack enthusiasm, be socially isolated, and have suicidal thoughts (Magwa, 2013). The most common psychological and psychosocial problems in adolescents are stress, anxiety, depression, and suicide (Horwitz, Hill, & King, 2011). Mental health problems affect adolescents in many ways. Adolescents are affected physically, intellectually, mentally, and socially, which can have a significant impact on their lives today and in the future. In the worst case scenario, they may resort to self-harm as a solution (Department of Mental Health, 2021). Adolescents not only face stress, but depression also poses a significant problem, with 18 percent reporting depression as a mood disorder that allows individuals to express their thoughts. Motivation, emotion, and behavior are common mental health problems that can occur in people of all ages (Beck, 2011). Adolescent depression, particularly during adolescence, can easily arise due to the onset of personal thoughts, the desire for independence, the emotional state, the ability to be independent, mood changes, the inability to regulate mood effectively, and the occurrence of oppressive and intense emotional expression (Santrock, 2014). According to statistics from the World Health Organization, more than 350 million people, or more than 4 percent of the world's population, suffer from depression. Past research studies have found that 45–69.30% of Thai adolescents studying in secondary school suffer from depression (Vatanasin, Thapinta, Thompson, & Thungjaroenkul, 2012). There is also a study on the prevalence of depression among college students who are in late adolescence, which is as high as 53.50% (Pandee, 2015). The study on the effects of depression on adolescents revealed that adolescents with depressive disorder were at risk of developing personality disorders, drug use, social adjustment problems, and a lack of academic achievement. After the first symptom, adolescents with depressive disorder had a 25–40% higher chance of recurrence than the general population (Tapinta, 2013). Researchers also found that patients with severe and chronic depression had a higher risk of death. Repeated deaths were 15 times higher than those of people who did not suffer from depression (Hongrisuwan, 2016). In the data-rich era, more and more consumers are producing information, whether it is electronic transactions or searching for online shopping information. Through the use of social media, these behaviors generate new information, thereby increasing the volume of information and establishing a decision-support system. As business systems continue to operate, the data will continue to grow to an even greater volume, which further reduces the efficiency of data access and processing, thus giving rise to a concept known as Big Data and one of those techniques that can automatically find patterns in huge amounts of data is a technique called Data Mining (Philuek, Pongsuk, & Panawong, 2022; Pongsuk, 2017). The study compared the performance of various classification algorithms, such as Support Vector Machine, K-Nearest Neighbors, Logistic Regression, Decision Tree, and Naive Bayes, in predicting depression and anxiety. We used evaluation metrics like accuracy, precision, specificity, and F1 score to assess the models. After implementing all the algorithms, (Malik & Khan, 2023) found that K-Nearest Neighbour outperformed logistic regression in predicting anxiety, stress, and depression levels in college students. The above highlights the significance of monitoring and surveillance of adolescents in light of the COVID-19 epidemic. This forces the students to adapt their teaching style to an online format, leading to feelings of stress and anxiety. In addition to the stress of the current situation, students will have to adjust to the new teaching style. As a result, students who are unable to adjust themselves experience stress and anxiety, leading to depression. Therefore, the researcher would like to study the problem by using techniques to analyze and predict the level of stress, depression, and academic performance of high school students. This will lead to the development of systems and tools to assist, monitor, and continue to care for these students.

1.1. Research Objectives

1. To study the problems of stress and depression among students in Grade 12th Students
2. To study techniques for analyzing and predicting stress, depression, and academic performance in Grade 12th Students.
3. To develop a platform to predict stress and depression among students in Grade 12th students.

2. Methodology

The research on using Machine Learning in stress, depression, and academic performance analytics for Grade 12th Students has the following steps:

2.1. Procedures for Conducting Research

- Study the stress, depression questionnaire.
- Study of geographic information systems and programs used.
- Study the school area in the target group area.
- The results of the stress assessment responses were analyzed and compared with each technique.
- Apply each analysis technique for analysis.

2.2. Scope of Research

The sample consisted of 510 students in the Secondary Education Service Area of Nakhon Sawan, Uthai Thani, Chainat, and Phichit schools.

Table 1. Schools that answered the questionnaire, a total of 5 schools.

School response count	Number of students who answered the questionnaire
1. Kuru Prachasan school	119
2. Taphan Hin school	240
3. Nongchang Wittaya school	52
4. Uthai Wittayakom school	22
5. Nawamintrachuthit school	77
Total	510

Table 1 presents the number of students who answered the questionnaire in each school. The first school was Kuru Prachasan School, located in Chainat Province, with 119 students. The second school, Taphan Hin School, represented Phichit Province with 240 students. The third and fourth schools were Nongchang Wittaya School and Uthai Wittayakom School, which represented Uthai Thani Province with 74 students; the last school was Nawamintrachuthit School in Nakhon Sawan Province with 77 students; a total of 510 students answered the questionnaire.

2.2.1. Content Scope

This form included three distinct types of assessments. 1) The Stress Assessment Scale (SPST-20), which is a Stress Symptom Assessment Questionnaire consisting of 20 questions, is an initial screening test for depression. 2) The 9-question Depression Assessment Scale (9Q), a Depression Symptom Assessment Scale consisting of 9 questions; and 3) the 8-question Suicide Assessment Scale (8Q), a Severity Assessment Scale of Suicide consisting of 8 questions.

2.3. Research Tools

2.3.1. Working Data

The Stress and Depression Assessment Form was prepared online by using the Google Forms assessment form.

- Data Analysis Program.
- Working equipment.
- Computer.

The techniques used in data analysis are as follows:

- Support Vector Machine (SVM) Technique.
- K-Nearest Neighbors (K-NN) Technique.
- Logistic Regression (LR) Technique.
- Decision Tree (DT) Technique.
- Naïve Bayes (NB) Technique.
- Microsoft Excel 2019.
- Jupyter writing program.

The results of the Stress and Depression assessment of 5 schools under the Secondary Educational Service Area Office of Nakhon Sawan, Uthai Thani, Chainat, and Phichit.

2.4. Method of Collecting Data

Step 1: Choose a questionnaire that matches the research objectives.

Step 2: Prepare a memo letter requesting permission to use the sample group and send it to all five schools.

Step 3: Receive assessment responses from all contacted schools.

Step 4: Choose the program for analysis.

2.5. Data Analysis

The researcher operates in accordance with the standards of the data mining development process. The Cross-Industry Standard Process for Data Mining (CRISP-DM) offers a research process that follows specific guidelines. The tasks assigned to each step are as follows:

2.5.1. Understanding the Problem (Business Understanding)

2.5.1.1. Data Understanding

The researcher examined the existing data and evaluated its suitability for analysis. There are methods, as follows: At this stage, to collect the above data, the researcher created an online form for assessing stress and depression using Google Forms. The questions included the student's email or line ID, as well as their gender. The school has a student Grade Point Average (GPA), and this form consists of three types of assessments: 1) The Stress Assessment Scale (SPST-20), which is a Stress Symptom Assessment Questionnaire consisting of 20 questions, is an initial screening test for depression. 2) The 9-question Depression Assessment Scale (9Q), a Depression Symptom Assessment Scale consisting of 9 questions; and 3) the 8-question Suicide Assessment Scale (8Q), a Severity Assessment Scale of Suicide consisting of 8 questions.

Describe data: 1) Current GPA; 2) Stress Assessment Scale (SPST-20), a 20-question stress symptom assessment questionnaire that serves as an initial screening test for depression. 3) The 9-question Depression Assessment Scale (9Q), a Depression Symptom Assessment Scale consisting of 9 questions; and 4) the 8-question Suicide Assessment Scale (8Q), a Severity Assessment Scale of Suicide consisting of 8 questions.

- Data preparation divides the information into three sub-steps.
- Data Selection: Choose pertinent data for further analysis. It is taken from multiple columns.
- Data Cleaning: This stage was the process of cleaning the data in order to format it in an appropriate format and eliminate missing data. The author used MS Excel to check if there were any missing data in each column

and roll, as shown in Figure 1.

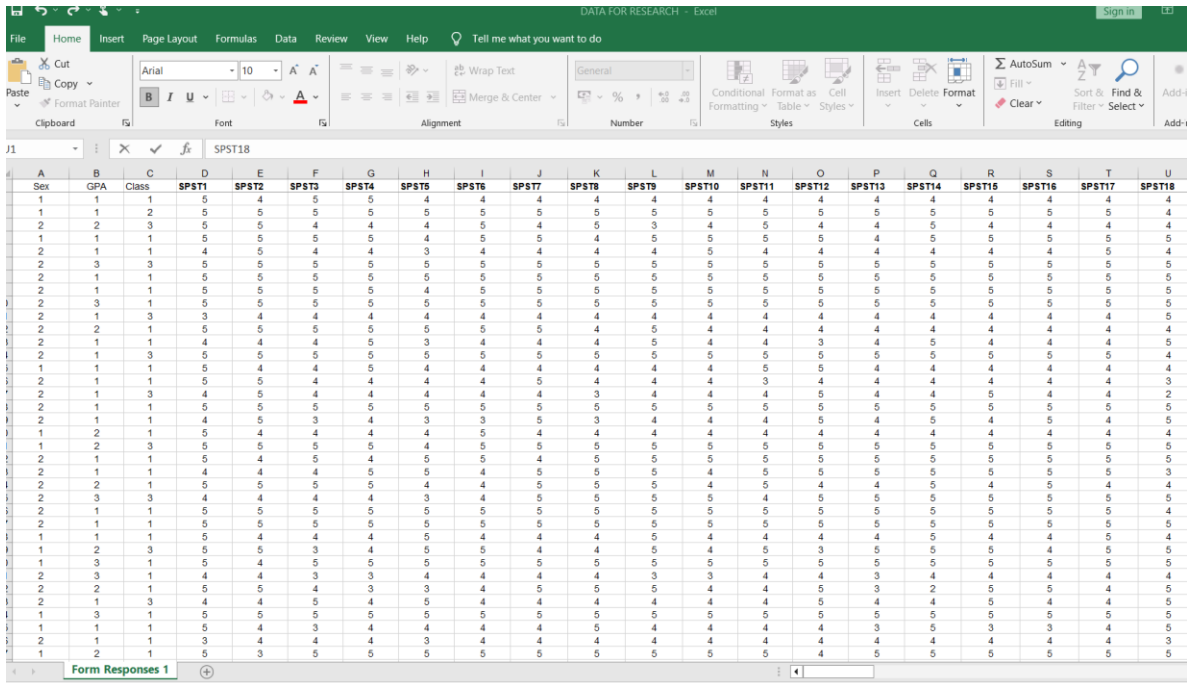


Figure 1. Transform data to Excel for analysis.

Data transformation is the process of transforming data into a format that is ready for use in analysis by specifying the quality variables, as shown in the following Table 2.

Table 2. Determination of the quality level of variables.

Quality level of variables	Description
ดีมาก (Very good)	Very good
ดี (Good)	Good
ปานกลาง (Moderate)	Moderate
พอใช้ (Fair)	Fair
ควรปรับปรุง (Adjust)	Adjust

Table 2 illustrates the process of determining the quality level of variables. The classification process employed five classes of quality-level variables. Because this study was conducted in Thailand, the researcher used Thai in terms of ดีมาก (very good), ดี (good), and ปานกลาง (moderate). พอใช้ (Fair) and ควรปรับปรุง (Adjust) as a class in testing the precision, recall, f1-score, and support in each machine learning technique.

2.6. Modeling Phase

This phase involved the selection of suitable models to improve the variables for the best results. At this stage, the researcher selected the following data mining techniques and algorithms:

- Support vector machine technique (SVM).
- K-Nearest neighbors' technique (K-NN).
- Logistic regression technique (LR).
- Decision tree technique (DT).
- Naïve Bayes technique (NB).

2.7. Evaluation Phase

By evaluating the model as a correlation rule, which takes into account considerations of support, validity, accuracy, recall, and F1-score values, we can determine the appropriateness of the model's application and how accurate the model predicts.

2.8. Deployment Phase

2.8.1. Development of the Platform Phase

We have developed a digital platform that analyzes students based on their learning style. 1) Students' current GPA; 2) The Stress Assessment Scale (SPST-20), a 20-question Stress Symptom Assessment Questionnaire, serves as an initial screening test for depression. 3) The 9-question Depression Assessment Scale (9Q), a Depression Symptom Assessment Scale with 9 questions, and 4) the 8-question Suicide Assessment Scale (8Q), a Severity Assessment Scale of Suicide with 8 questions, which divides the creation process into two sections. It uses data mining to develop a model based on the CRISP-DM data analysis process, as well as the development of information systems through the Systems Development Life Cycle (SDLC) (Phakdiwatthanakul & Panichkul, 2008).

3. Results

3.1. The results of students' stress and depression and Machine Learning techniques in analytic.

3.1.1 The results of stress and depression of Grade 12th students

Table 3. Results of a study of stress and depression problems among students of grade 12th students.

Measures of dispersion	Sex			G12	GPA		
	N	Male	Female		N	Male	Female
Count	510	137	373	510	510	137	373
Mean	1.72	1.62	1.84	0.84	3.92	3.82	4.02
Std.	0.44	0.39	0.38	0.36	0.98	1.05	0.94
Min.	1	1	2	0	1	1	1
25%	1	1	2	1	3	2	3
50%	2	1	2	1	4	3	4
75%	2	1	2	1	5	4	5
Max.	2	1	2	1	5	5	5

Table 3 presents the stress and depression results among Grade 12 students, which revealed that out of a total of 510 students, 137 were male and 373 were female. The mean incidence of stress and depression was 1.72. The average male tendency to stress and depression was 1.62, while the female mean was 1.84. The male mean is 0.22 lower than the female mean. The mean total GPA was 3.92, divided into a mean male GPA of 3.82 and a mean female GPA of 4.02. The mean GPA of males was 0.20 lower than that of females. They were less likely to experience stress and depression than females and had lower grades than females, but females who were more prone to stress and depression had a higher GPA and were Grade 12 students. They had an average of 1.58 times more stress than depression.

The results of using 5 machine learning techniques for analyzing the relationship between stress, depression, and academic performance of Grade 12th students in each technique are shown in Table 4.

Table 4. Test results of KNN, LR, SVC and NB technique.

Model	Class	Fair	Good	Moderate	Very good	Accuracy	Macro avg.
K-nearest neighbors (KNN)	Precision	0.00	0.36	0.26	0.58	0.39	0.30
	Recall	0.00	0.55	0.25	0.44		0.31
	F1-score	0.00	0.44	0.26	0.60		0.30
	Support	12.00	38.00	20.00	32.00	102.00	102.00
Logistic regression (LR)	Precision	0.62	0.62	0.25	0.90	0.65	0.60
	Recall	0.42	0.76	0.20	0.88		0.56
	F1-score	0.50	0.68	0.22	0.89		0.57
	Support	12.00	38.00	20.00	32.00	102.00	102.00
Support vector classification (SVC)	Precision	0.00	0.82	0.52	0.89	0.76	0.56
	Recall	0.00	0.87	0.70	0.97		0.63
	F1-score	0.00	0.85	0.60	0.93		0.59
	Support	12.00	38.00	20.00	32.00	102.00	102.00
Naïve bayes (NB)	Precision	1.00	1.00	1.00	1.00	1.00	1.00
	Recall	1.00	1.00	1.00	1.00		1.00
	F1-score	1.00	1.00	1.00	1.00		1.00
	Support	12.00	38.00	20.00	32.00	102.00	102.00
Decision tree (DT)	Precision	1.00	1.00	1.00	1.00	1.00	1.00
	Recall	1.00	1.00	1.00	1.00		1.00
	F1-score	1.00	1.00	1.00	1.00		1.00
	Support	12.00	38.00	20.00	32.00	102.00	102.00

Table 4 displays the test results for the Support Vector Machine (SVM), K-Nearest Neighbors (K-NN), Logistic Regression (LR), Naive Bayes Technique (NB), and Decision Tree (DT), providing a summary as follows: Testing for the K-Nearest Neighbors (KNN) technique showed accuracy at 0.39, Logistic Regression (LR) showed accuracy at 0.65, Support Vector Machine (SVM) showed accuracy at 0.76, Naïve Bayes (NB) showed accuracy at 1.00, and Decision Tree (DT) showed accuracy at 1.00. We can conclude that Decision Tree (DT) and Naive Bayes (NB) are the most accurate techniques in data analysis.

3.2. Platform Evaluation

The results of the assessment of the platform by experts are shown in Table 5.

Table 5. The results of the assessment of the efficiency of information systems from 5 experts.

Assessment item	Mean	S.D.	Interpretation
1. Function requirement	5.00	0.000	Very good
2. Function	4.80	0.447	Very good
3. Usability	4.60	0.547	Very good
4. Performance	4.80	0.447	Very good
5. Security	4.40	0.547	Very good

Table 5 displays the results of a five-expert assessment of the efficiency of information systems, which received very good scores in all categories: (1) function requirement, (2) function, (3) usability, (4) performance, and (5) security. This means that the digital platform has good quality and is appropriate to use.

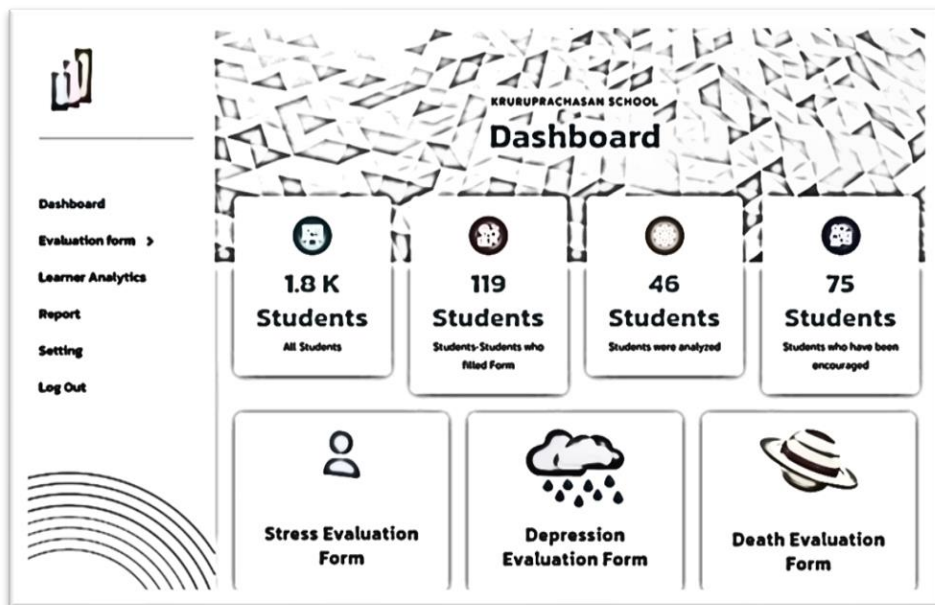


Figure 2. Dashboard of platform.

Figure 2 shows the dashboard of the platform. The platform presents the number of students who used this platform in terms of analytics or to predict their stress and depression. The dashboard consisted of the Evaluation Form function, the Learner Analytics function, the Report function, the Setting function, and the Logout function. Students who have never used this platform before must sign up, and they will be granted permission.

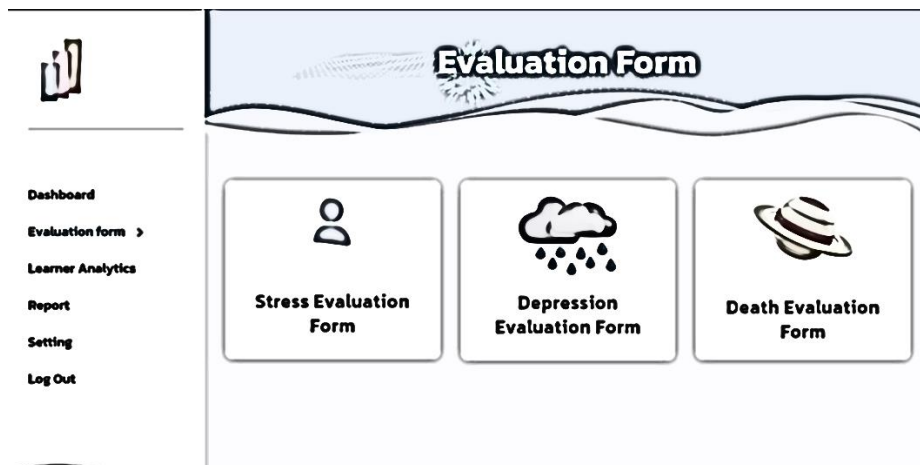


Figure 3. Dashboard of evaluation form.

Figure 3 shows the functions of the evaluation forms, particularly the stress evaluation form and the depression evaluation form. After students log in to the platform, they will use the Evaluation Form function to access these two forms, and they just click on any form they would like to evaluate themselves.

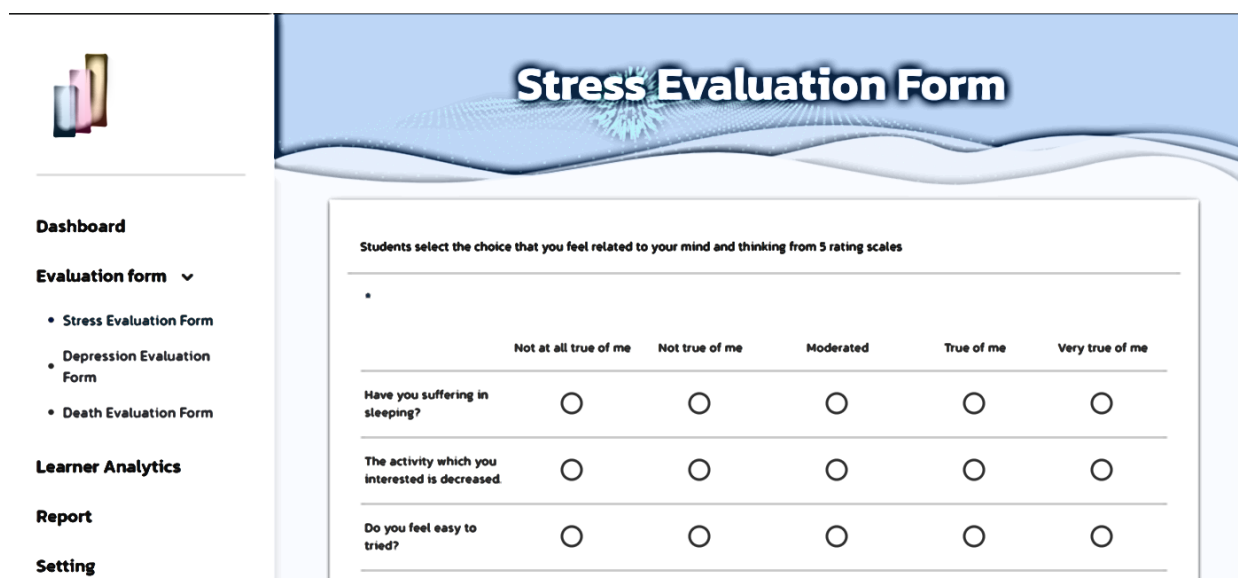


Figure 4. Example of stress evaluation form.

Figure 4 illustrates the details, including a question that students can answer by selecting from 1 (not related) to 5 (mostly related to me). The Stress Evaluation Form is used as an example in this figure. Once students have completed all questions, they can view their results in the Learner Analytics function and utilize the Report function to print their results in a PDF file.

Volunteers obtained the results of a survey of 117 students about their satisfaction with using digital platforms.

Table 6. Students' satisfaction in using digital platform (N = 117).

Assessment item	Mean	S.D.	Interpretation
1. Information criteria			
1.1 The speed of displaying data is categorized to make it easy to access	4.56	0.61	Highest
1.2 The databases are kept up-to-date	4.52	0.54	Highest
1.3 The database can be used to benefit you and the organization effectively	4.36	0.71	High
1.4 Information in the system is accurate and complete, useful for operations and decision-making	4.48	0.60	High
1.5 The information is organized into categories for easy searching	4.17	0.86	High
1.6 Formats and techniques for presenting information	4.41	0.64	High
1.7 There is a security rating or permission to access information	4.52	0.56	Highest
1.8 Attractiveness of information systems	4.41	0.64	High
Total	4.43	0.48	High
2. Performance criteria			
2.1 Can easily find or access the required information	4.44	0.69	High
2.2 There are functions or tools to use appropriately	4.40	0.64	High
2.3 System efficiency/Speed of response	4.35	0.84	High
2.4 The system is stable, can be accessed at any time	4.42	0.74	High
2.5 The display format on the screen is suitable and beautiful	4.30	0.67	High
2.6 There is information that is useful to users	4.54	0.62	Highest
2.7 The system is easy to use and not complicated	4.53	0.53	Highest
Total	4.43	0.54	High

Table 6 shows the level of satisfaction of 117 students who use digital platforms, with an average level of high satisfaction with information criteria ($M = 4.43$, $S.D. = 0.48$) and high satisfaction with performance criteria ($M = 4.43$, $S.D. = 0.54$). Three items make up the information criteria: categorizing the speed of data display for ease of access, maintaining up-to-date databases, and providing a security rating or permission to access information, all of which students find most satisfying. In terms of performance criteria, there are two items: there is information that is useful to users, and the system is easy to use and not complicated, which means students have the highest satisfaction level.

4. Discussions

The discussion of the results of this research consisted of two topics: 1) to study the problems of stress and depression among students in Grade 12th students, 2) to study techniques for analyzing and predicting stress levels, depression, and learning performance, and 3) to evaluate stress and depression prediction platforms among Grade 12th students. The learning of Grade 12th students is as follows:

1. The results of a study on stress and depression problems among Grade 12 students found that females were more likely to experience stress and depression, with males having an average lower than females at 0.22. This included the average student's GPA. Females with a good GPA were more likely to experience stress and depression than students with a lower GPA. The COVID-19 epidemic has forced everyone to adapt their lifestyles and livelihoods, including in education. The traditional on-site teaching style has been replaced by online learning, necessitating students to adjust to this new environment. Living in a house means they will face stress because they may not be aware of the COVID-19 epidemic situation. In addition to students having to deal with the epidemic situation, grade 6 students also need to prepare for university, resulting in severe stress among grade 6 students, which may make them more prone to depression. Numerous scholars have suggested that adolescents' self-expectations and their family's perceptions of their lack of preparedness for education may be the root cause of stress. Prepare yourself, including your grades (Inprom & Nimnuan, 2006). Researchers have stated that when considering the factors of family expectations on stress levels, the results of this study also found that family expectations for university entrance exams were more important factors positively correlated with stress ($p < .05$, $r = .148$). In addition to the above two factors, the throughput factor was associated with increased stress ($p < .01$, $r = -.256$). The lower the family's income, the higher the stress level of adolescents. Researchers conducted a study on the depression levels of Grade 12 students in Samut Songkhram Province, who were preparing for their university entrance examination. It was found that 21.4% of adolescents had depression to the degree of clinical significance that they should be referred for diagnosis (Uratmanee & Lertsamran, 2017). The research also revealed that Zhou et al. (2023) developed a machine learning model to detect and distinguish depression, anxiety, and apathy in older adults with mild cognitive impairment based on speech and facial expressions. The study by Singh, Gupta, Singh, and Agrawal (2022) which explores the use of machine learning models to predict the levels of depression, anxiety, and stress based on the DASS-42 psychometric test results and demographic information, aligns with the model's strong classification performance, achieving a weighted-average F1 score of 96.6%. The researchers looked at a number of techniques and ensemble learning methods, such as Random Forest, Decision Tree, Support Vector Machine, AdaBoost, CatBoost, and Extreme Gradient Boosting (XGBoost). The Support Vector Machine did better than the others, with an F1-measure of 94% for depression, 95% for anxiety, and 91% for stress prediction.

2. The study analyzed and predicted stress levels, depression, and academic performance of Grade 12th students by comparing the efficiency and accuracy of five forecasting models. The logistic regression model had an accuracy of 102%, while the support vector machine technique had an accuracy of 102%. The accuracy was 102%, the Decision Tree technique was 102%, and the Naïve Bayes technique was 83%. With an accuracy of 102%, a decision tree surpasses the accuracy of the four techniques mentioned above. Research by Thamsombat (2012) suggests that we can use this technique to predict stress and depression. The goal of this research is to create a decision support system that utilizes the Decision Tree algorithm to guide users in selecting a mobile internet package based on their individual behaviors. Models generated from the Decision Tree algorithm were used to determine the most accurate model before implementing it in an open source web framework for building modern web apps and services (ASP.NET) by using C# in development and using a standard language for storing, manipulating, and retrieving

data in databases (SQL Server 2008 databases) developed in the form of Web-Based applications, and Weka 3.6.2 was used to validate the model generated by the system. The result was that the model generated by the Decision Tree ID3 algorithm had a higher accuracy than C4.5 (J48) with a Correctly Classified Instances value of 92.3% when tested with 1000 sets of Training Data pools and when the ID3 decision tree algorithm was tested on 500 sets of Testing Data yielded the test results with validity values was 92.2%, and when considering the Confusion Matrix, it was found that the prediction results from the model had the actual number of data and the number of data from the model's prediction had a total mean of 83.06%, which was a rather high mean, and also related to the paper of Aggarwal and Goyal (2022) which presents a system for predicting if a player suffers from psychological illnesses such as anxiety and depression by combining game and player information with a self-esteem measure. Four different machine learning classifiers were tested, and the Decision Tree classifier showed the best accuracy for all predicted parameters. For the Generalized Anxiety Disorder questionnaire (GAD), the decision tree obtained an accuracy of 100%, and for the Short 5-item Instrument designed to measure global cognitive judgments of satisfaction (SWLS questionnaire), it obtained an accuracy of 84.71%. However, some Machine learning algorithms, specifically neural network algorithms, show promising results in predicting depressive episodes. In this study Trivedi et al. (2022) and Sandhu, Huma Jabeen, Ali Mudassar, and Raza (2022) utilized neural network algorithms to achieve a classification accuracy of 97.2% for depression prediction, offering a technical solution to this mental challenge. The experimental results demonstrate an accuracy of up to 76.5% when using k-nn without PCA (Principal Component Analysis), and this accuracy rises to 76.6% when using PCA (Principal Component Analysis). Ahmed et al. (2022) found that machine learning models have the potential to complement traditional screening methods and provide insights into the mental health of the public.

3) The use of digital platforms: a satisfaction survey conducted among students using these platforms revealed high levels of satisfaction, confirming the platform's speed in displaying results. Information is categorized to facilitate easy access. The database is up-to-date. Schools can effectively use the database. The information in the system is accurate and complete, which is beneficial for operations and decision-making. The system organizes data into categories to facilitate easy searching of formats and methods for data presentation. The system arranges security levels and sets permissions. The system is stable and accessible at all times. The screen displays information in a suitable and beautiful format that is useful to the user. The system is convenient and not complicated to use.

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