KnE Social Sciences
ASABEC 2023
Annual Symposium on Applied Business Economics and Communication 2023
Volume 2024

Research Article

Correlational Study of Mental Health and Achievement Among University Students

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Abstract.

Mental health is a state of mental well-being that enables individuals to cope with life pressures, realize their capabilities, learn effectively, work proficiently, and contribute to their communities. According to UNICEF Indonesia, several conditions that affect a person's mental health, including anxiety, depression, panic, and stress. Data shows that 1 out of 3 Indonesian teenagers experience mental health issues. These issues have spurred the present research to analyze the correlation between students' mental health and their academic performance on campus. This study focuses on examining the correlation between mental health and the grade point average (GPA) of accounting students at the Jakarta State Polytechnic (PNJ). The research used a combination of eXtreme Gradient Boosting (XGBoost) and Shapley Additive Explanations (SHAP). This approach facilitates the analysis of the correlation between mental health and GPA among students at PNJ. In addition to its research sample, this methodology also constitutes an innovative aspect of the study. Based on the research conducted, the correlation between mental health indicators such as stress, anxiety, and depression and a decline in students' GPA is found to be low. However, in extreme cases, feelings of anxiety and stress exhibit a negative correlation with GPA reduction in students.

Keywords: GPA, mental health, XGBoost, shap, correlation

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Published: 29 August 2024

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ASABEC 2023 Conference Committee.

1. Introduction

Mental health is a state of mental well-being that enables people to cope with the stresses of life, realize their abilities, study well and work well, and contribute to their communities. Mental health is essential for personal, community and socio-economic development [1]. According to UNICEF Indonesia, there are several conditions that affect a person's mental health, including anxiety, depression, panic and stress. These four things are very natural for everyone to experience. However, if it continues, this will become a problem.

In the context of higher education, students are one of the components in the adolescent age range who often face mental health problems. According to the findings of the Indonesia National Adolescent Mental Health Survey (I-NAMHS), 2.45 million

teenagers were diagnosed with mental disorders and 1 in 3 (34.9 percent) equivalent to 15.5 million teenagers had a mental health problem in the last 12 months. Therefore, it is important to discuss in more depth the impact on students' mental health [2].

In this research, the author wants to explore the correlation between student mental health and the Student Achievement Index (GPA) focusing on Jakarta State Polytechnic (PNJ) students majoring in Accounting. The instrument used to measure mental health is based on four things, namely levels of anxiety, depression, panic attacks and stress. The method used is the correlation analysis method by building a regression model using the XGBoost method and calculating the SHAP value which describes the influence of predictor variables on student GPA.

Previous research by Akhdan and Aminatun [3] showed that anxiety has a strong influence on student achievement. Then research conducted by Hartley [4] with a sample of 605 respondents showed that there is a strong relationship between toughness and mental health on academic persistence.

Mental health can be defined as a person's psychological and emotional condition that allows him or her to function optimally in everyday life [1]. The World Federation for Mental Health is a condition that may provide physical, emotional and intellectual development for a person that does not conflict with the interests of other people. According to Law Number 3 of 1966, Mental Health is a condition that allows a person's physical, intellectual and emotional development and must be in harmony with the conditions of other people [5]. Good mental health fosters well-being, enabling individuals to cope with life's stresses and function productively, while also equipping them with resilience to face abnormal and potentially destructive stressors [6]. Meanwhile, according to Massuhartono and Mulyanti [7] mental health disorders, such as depression, anxiety and stress can disrupt a person's cognitive, affective and behavioral functions, thus having a negative impact on academic achievement.

Academic achievement is the learning result achieved by students in the educational process at higher education, which is usually measured by the cumulative achievement index (GPA). Academic achievement is an indicator of student success in completing their studies and preparing themselves for future careers. Academic achievement is influenced by various factors, both internal and external, which interact with each other [8] one of the influencing internal factors is mental health.

Several studies have shown a relationship between mental health and student achievement index.

A study on medical students in Indonesia indicates a significant correlation between depression and a decline in GPA [9]. Similar findings have been reported among students in other countries, such as a study in the United Kingdom that found a negative association between anxiety and stress with academic performance [10]. Meanwhile, Eisenberg et al. [11] conducted a descriptive study and demonstrated that depression and anxiety are among the factors correlated with low GPA and dropout rates in academic settings.

In this study, researchers will evaluate the correlation between mental health and cumulative achievement index for students in Indonesia. The focus of this research observation is students from the Accounting Department at the Jakar State Polytechnic.

2. Research Methods

In this study, researchers will evaluate the correlation between mental health and cumulative achievement index for students in Indonesia. In this research, the students who will be observed are students from the Accounting Department at the Jakarta State Polytechnic. This is done to ensure the equality of the matrices used for the GPA of all observers.

The method that will be used in this research is to use a survey method and data processing using machine learning or artificial intelligence to help unravel the correlation between mental health and student GPA. The survey used in this research consists of questions that meet the principles of psychometric surveys where the question in the survey is a statement and the answers in the survey describe the observer's attitude towards the statement given [12].

The results of the survey that has been carried out then become predictor variables in the machine learning regression model which is used to predict the response variable which is the GPA of the relevant students. The regression model used in this research is (eXtreme Gradient Boosting). XGboost is a machine learning algorithm that is effective in regression problems. This model is an application of an ensemble method that combines predictions from decision trees, each of which was trained using a different subset of data. XGBoost has been proven to be effective in solving various regression problems

such as property price prediction, stock prices, and energy demand [13, 14]. The following is the objective function that must be minimized in the t-th iteration

$$\tilde{L}^{(t)} \simeq \sum_{i=1}^{N} \left[g_i f_t\left(x_i\right) + \frac{1}{2} h_i f_t^2\left(x_i\right) \right] + \square\left(f_t\right)$$

Where

$f_t\left(x_i\right)$ output from the decision tree or base learner model

$\square\left(f_t\right)$ loss from the decision tree or base learner model

$g_i$first derivative of the loss function

g_i second derivative of the loss function

t iteration

To describe the correlation between mental health and student GPA based on the survey conducted, researchers plan to use the SHAP or Shapley Additive Explanations method, which is a method for describing the magnitude of the influence of predictor variables on predictions from machine learning models. This concept was introduced by Lundberg and Lee [15] and is based on the concept of game theory. There are several methods for calculating SHAP values, including KernelSHAP, TreeSHAP, and DeepSHAP, where each method is an optimization of different model types. However, TreeSHAP is an algorithm that is proven to be accurate and more efficient on complex data and models [16]. SHAP values have been used in various machine learning applications such as regression, classification, and time series forecasting [15, 17, 18]. The following is the formula used to calculate the SHAP value in the XGBoost model:

$$SHAP_j\left(i\right) = phi_0 + \left(\frac{1}{N}\right) * sum(\delta_{phi2} - \delta_{phi1})$$

Where

j predictor variables

phi_0 Average predictions from the model over the entire dataset

phi_1 Model predictions when the baseline value is the predictor variable

phi_2Model prediction when the actual value is the predictor variable

δ_{phi1} : the difference between phi_2 and phi_0

δ_{phi2} the difference between phi_1 And phi_0

By using the SHAP method, the author can evaluate factors that are positively or negatively correlated with student GPA.

3. Results and Discussion

In this study, PNJ administration students were faced with a questionnaire with 3 sections representing levels of stress, anxiety and depression and each section consisted of 7 statements. Students are then given the option to respond to the statement given, where 1 means the student strongly disagrees with the statement given and 5 means the student strongly agrees with the statement given. The following are the statements given in the questionnaire:

S1. I feel that I get angry easily over trivial things

S2. I find it difficult to be patient with disturbances in the activities I do

S3. I often can't feel positive feelings

S4. I feel sad and depressed

S5. I don't feel enthusiastic about anything

S6. I feel that life is not worthwhile

S7. I worry about situations where I might panic and embarrass myself

A1. I tend to overreact in situations

A2. I often feel restless

A3. I realized that I was easily irritated

A4. I don't seem to be able to do any activities anymore

A5. I feel like my mouth is often dry

A6 I often feel panic

A7. I often notice changes in my heart rate, even though I haven't done any physical activity before

D1. I feel like I use up a lot of energy when I'm anxious

D2. I find it difficult to relax

D3. I feel like there is nothing to look forward to in the future

D4. I felt that I was worthless as a human being

D5. I have difficulty breathing (for example: I often feel breathless even though I haven't done any physical activity before)

D6. I often feel shaking (for example: in my hands)

D7. I feel scared for no apparent reason

There were 177 respondents consisting of 32 men and 144 women. Respondents were also asked for their cumulative achievement index scores in the last 2 semesters

which would then be used as a marker of whether there was an increase in their GPA in the last semester or not. This marker will be used to examine the relationship between mental health and students' cumulative achievement index. Based on the data that has been accumulated, an increase in GPA occurred in 99 respondents while a decrease in GPA occurred in 78 respondents.

From the results of the questionnaire given to PNJ business administration students, it was obtained the distribution of answers from the questionnaire is as follows.

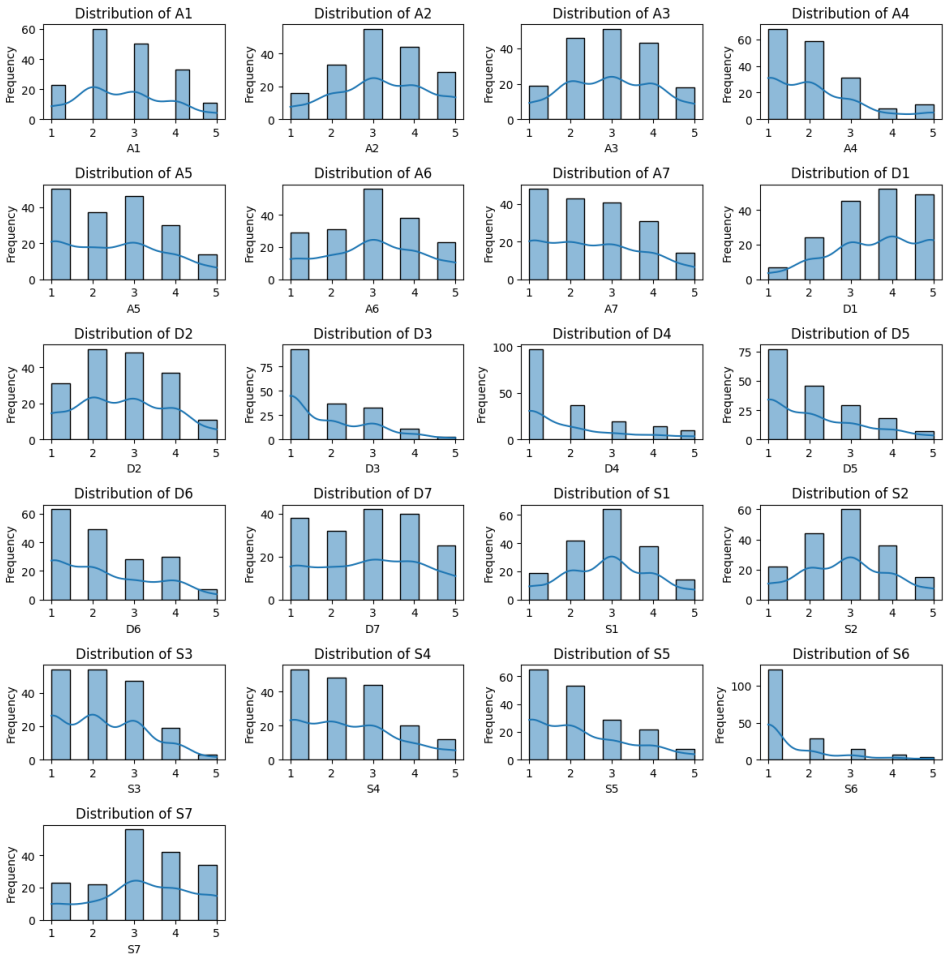

Figure 1: Distribution of scores for each statement in the questionnaire.

Based on Figure 1, it can be seen that a right skewed distribution occurs in statements A4, A5, A7, D3, D4, D5, D6, S3, S4, S5, and S6, which means that the majority of respondents do not agree with the statement. Meanwhile, left skewed distribution occurs in statement D1, which means the majority of respondents agree with the statement. Normal distribution occurs in statements A1, A2, A3, A6, D2, D7, S1, S2, and S7, which means that the majority of respondents have a neutral opinion regarding these statements.

Next, the Pearson correlation will be reviewed between the questionnaire results obtained and the marker variable 'is_decrease' which illustrates that there has been a decline in students' GPA. Pearson correlation describes the relationship between two variables. In this case, the correlation between each opinion in the statement in the questionnaire and the decline in GPA among students will be reviewed.

Figure 2: Pearson correlation for each statement in the questionnaire on the decline in GPA among students.

Based on Figure 2, it can be seen that in the entire population of respondents there is no opinion on a statement that has a high correlation with a decrease in student GPA. However, if a subset of the population is taken based on gender, the A4 statement in men has a fairly large correlation compared to other statements.

Then the XGBoost machine learning model was trained using the questionnaire data that had been obtained. The Shapley value is then used to interpret the tree model that has been created, in this case the Shapley value will be used to interpret the XGBoost model that has been created. The following is an overview of feature importance in the XGBoost model that has been created. Feature importance describes the features, in this case the questionnaire statement, which are very influential in determining whether a student's GPA will decrease. The following is the feature importance of the XGBoost model which has been created using Shapley values.

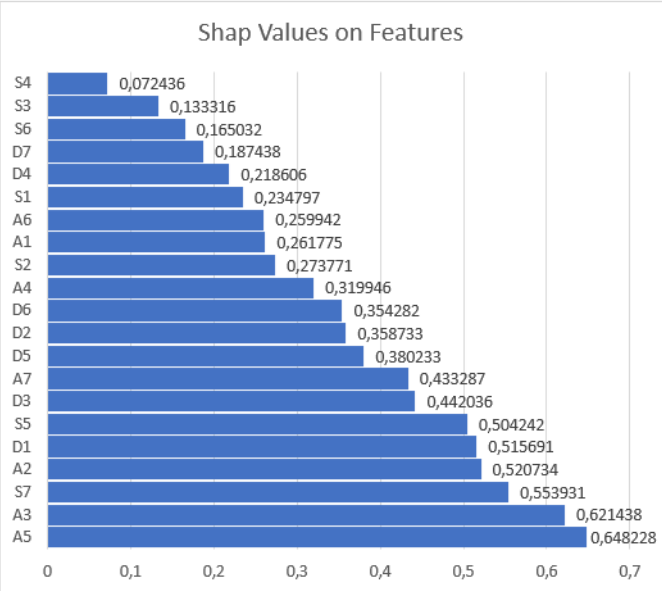

Figure 3: Shap Values for each statement in the questionnaire.

Based on Figure 3, statements A5, A3, and S7 are the 3 statements that have the greatest influence on determining whether a student's GPA will decrease. Next, we will see the effect of a decrease in GPA on student opinions regarding the statements in the questionnaire. This effect will be illustrated using a beeswarm plot where the x-axis in this graph depicts the Shapley value and the y-axis depicts the features used in the model. Meanwhile, the points on this graph depict observations or respondents in this study.

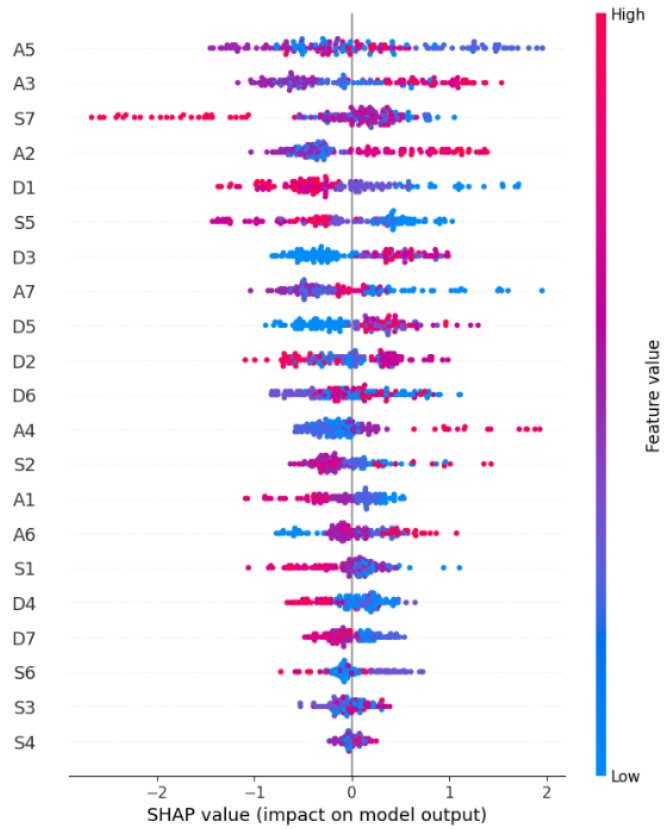

Figure 4: Bee Swarm graph of shape values along with the direction of the statements in the questionnaire.

Based on Figure 4, it can be concluded that the relationship between the possibility of a decline in GPA among students and the opinion of the questionnaire in this study is as follows:

The more you disagree with statements A5, S7, D1, S5, A7, D2, D6, A1, S1, D4, D7, S6, S3, and S4, the higher the possibility of a decrease in GPA

The more you agree with statements A3, A2, D3, D5, A4, S2, and A6, the higher the possibility of a decrease in GPA

Force plots can be used to illustrate the influence and direction of each feature on model predictions, in this case the decline in GPA among students. The following is a force plot graph from the XGBoost model that has been built.

Based on Figure 5, it can be seen that D2, S7, D5, D3, A3, S2, A2, and D1 are the features that have the most influence on model predictions with D1 having a negative direction on model predictions and the rest having a positive direction on model predictions. The negative direction means that the more the respondent agrees with the statement, the lower the possibility of a decline in the respondent's GPA and

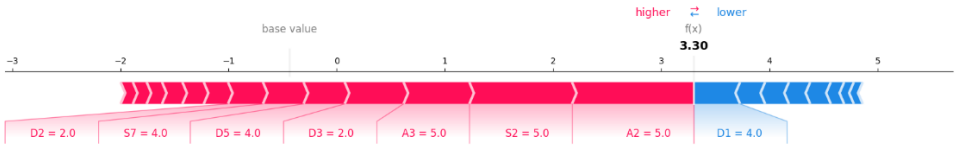

Figure 5: Force plot depicting the strength and direction of statements in the questionnaire on the possibility of a decrease in GPA.

the positive direction means that the more the respondent agrees with the statement, the higher the possibility of a decline in the respondent's GPA.

The next step is to train the XGBoost model with the accumulated scores from each section, namely stress, anxiety and depression. This step was taken to determine the influence of these three elements on the decline in GPA among students. The following is the distribution of accumulated scores from the three elements, namely stress, anxiety and depression in PNJ business administration students (Figure 6).

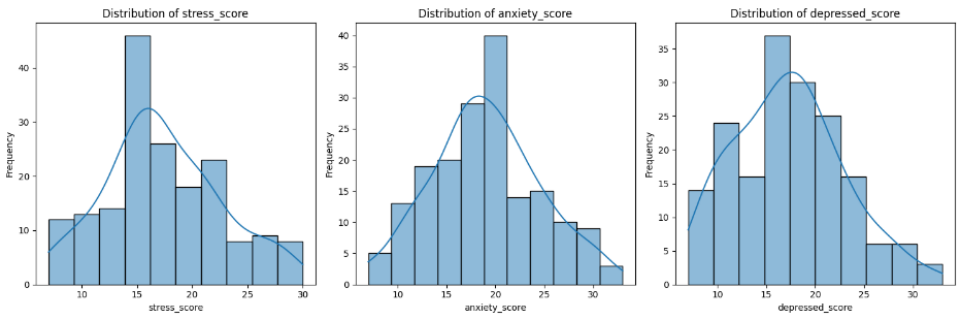

Figure 6: Distribution of accumulated scores for the elements of stress, anxiety and depression.

The same thing is then done to the XGBoost model which has been trained using the accumulated scores. The following is a beeswarm plot of the XGBoost model trained using the accumulated scores.

Shap values from accumulated mental health element scores.

Based on Figures 7 and 8, it is clear that the relationship between each accumulated score does not have a strong influence on the decline in student GPA. However, if viewed from an extreme point, anxiety and stress have a negative direction, meaning that the lower a student's anxiety or stress score, the greater the possibility of a decrease in the student's GPA. The opposite applies to depression scores which have a positive direction, meaning that the higher a student's depression score, the greater the possibility of a decrease in the student's GPA.

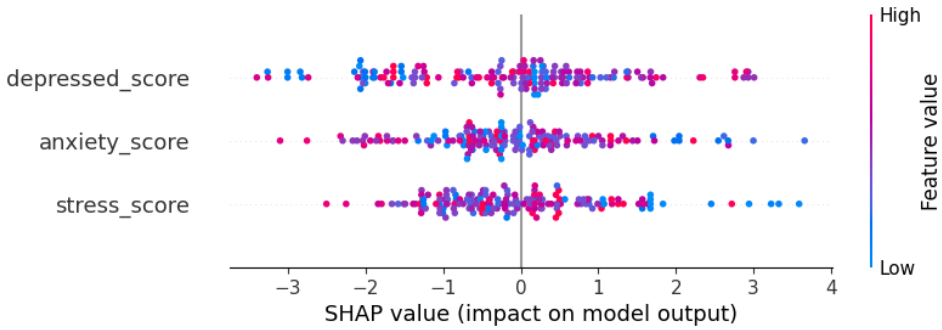

Figure 7: Beeswarm graph of shape values along with the direction of the accumulation of mental health element scores.

4. Conclusion

Student mental health is only one factor that causes a decline in student GPA. Based on research that has been conducted, the correlation between mental health in the form of stress, anxiety and depression has a low correlation with a decrease in student GPA. However, in extreme cases, anxiety and stress have a negative direction in reducing students' GPA. This means that the possibility of a decrease in GPA for students will be lower as feelings of anxiety and stress increase. Meanwhile, at the extreme point, the more depressed a student feels, the greater the possibility of a decline in their GPA.

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