MACHINE LEARNING MODEL BASED ANALYSIS OF TEST ANXIETY'S EFFECTS ON ACADEMIC ACHIEVEMENT

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Abstract

Recent advancements in artificial intelligence and machine learning have significantly impacted healthcare education by improving efficiency, accuracy, and standardization in patient data analysis. The effects of self-efficacy and test anxiety on academic achievement, using machine learning-based analysis, have attracted attention in many studies, which justify the fact that more research is needed to examine and predicate the real impact of test anxiety on academic achievement. A machine learning method based on the feedforward artificial neural network, the multi-layer perceptrons (MLPs) is used. The study identified five crucial factors for attaining meaningful academic achievement: having a positive mindset, a well-thought-out plan, being accountable for progress, acknowledging potential stress and negative emotions, and monitoring and evaluating one's achievements and efforts. The results showed that having a positive mindset (AR1) was the most important factor for success, with an important rate of 0.997. Monitoring and evaluating one's achievements (AR5) and a well-thought-out plan (AR2) were also essential factors, with important rates of 0.996 and 0.981, respectively. The study also identified five factors related to test anxiety and academic achievement. The other important factor was AT1 - that the visible signs of nervousness (sweaty palms, shaky Hands, etc.) before a test mainly impacts academic achievement with a rate of .146. Followed by AT7, which stated that some students are more prone to nervousness during exams, ultimately affecting their performance, with an important rate of 0.126. The study also used machine learning to identify distinct patterns in academic resilience and test anxiety factors that affect academic achievement in different student groups. The findings form part of a 'blueprint' to inform the development of targeted interventions that cater to the unique needs of student populations and lead to improved academic outcomes. A prediction model has been created to forecast the relevant data and analyze future conditions.

Keywords: Machine Learning Model, Test Anxiety, Academic Achievement, Multi-Layer Perceptrons, Prediction Model.

1. INTRODUCTION

The progress made in artificial intelligence (AI) and machine learning (ML) has had a profound impact on healthcare education. It has led to enhanced efficiency, accuracy, and standardization in the analysis of patient data. Models based on artificial intelligence and machine learning help develop predictive models that determine future values, which help to develop plans based on accurate knowledge of the required data. ML revolves around teaching a machine using an algorithm to simulate human tasks such as decision-making, speech recognition, and pattern recognition [1]. For example, in the medical domain, AI helps in disease management, prescription of a treatment plan, or analyzing

large amounts of medical data, which helps in making informed decisions. The development of predictive models based on ML methods and artificial intelligence helps determine the future state of patients at risk and develop early preventive solutions [2]. Similarly, studying psychological variables in students' academic environments can help understand their cognitive levels and behavioral traits, which can shape their future personalities. However, factors such as test anxiety, self-efficacy, academic resilience, and perceptions of academic challenges can negatively affect students' personal and academic development, leading to dropping out or leaving the study. [3]. Some factors negatively affect students and lead to dropping out and leaving the study, such as Test Anxiety, Self-efficacy, Academic Resilience, afraid of the tasks they must accomplish, and perceptions of the next stage and its challenges, which affect their personal and academic development and undermine their motivation and commitment to study [4].

Given the foregoing, it is important to consider both the personal and academic factors to understand the process of learning. Further, studies should understand the lack of skills and strategies to deal with academic requirements so as to develop effective mathematical models to analyze these factors and to conclude plans that raise student efficiency and reduce disadvantages. The psychologist Albert Bandura in his social cognitive theory posits that an individual's self-efficacy refers to their belief that they will succeed in achieving a particular goal. The concept was developed by psychologist Albert Bandura as part of his social cognitive theory. A person's level of motivation, behavior, and achievement can be influenced by their self-efficacy beliefs. Individuals with high self-efficacy beliefs are more likely to strive for success, persist in the face of obstacles, and take on challenging tasks. When individuals have low self-efficacy beliefs, they may avoid challenging tasks, give up easily when confronted with obstacles, and feel inadequate and helpless. Several factors can contribute to self-efficacy, including past experiences, social support, and verbal persuasion. When individuals have succeeded at similar tasks in the past, they are more likely to believe in their own abilities in similar situations [5]. Positive feedback or criticism also lowers self-efficacy beliefs, in contrast to social support and encouragement [6]. People with testing anxiety experience it whenever they are preparing for an exam or in an evaluation situation. Nervousness in various forms, including mild nervousness and severe emotional distress, can prevent people from performing well on tests and exams. Students' academic resilience is their ability to overcome obstacles and adversity and continue to succeed even in the face of failure. Students need to be able to persevere, adapt, and thrive despite academic challenges, including difficult coursework, poor grades, and negative feedback [7].

According to the current studies about the test anxiety, self-efficacy, academic resilience, the following are the main points that examine the student performance:

➢ Develop effective mathematical models: To analyze these factors and conclude plans to improve student efficiency, personal and academic factors and the lack of skills and strategies to deal with academic requirements must be studied. Self-efficacy, an individual's belief in their ability to achieve a particular goal, can significantly influence motivation, behavior, and achievement. Several factors, including past experiences, social support, and verbal persuasion, can contribute to self-efficacy. Test anxiety,

academic resilience, and overcoming obstacles and adversity are critical factors that impact student performance.

➤ Examine Test anxiety: Test anxiety refers to the feelings of nervousness, worry, and stress that students experience before, during, or after taking an exam.

➤ Supportive factors: Some helpful factors lead a person to reduce anxiety about tests, including fear of failure and pressure from others. On the other hand, academic flexibility can increase the student's ability to persevere to overcome academic challenges. Here we can mention some factors contributing to raising academic flexibility, including cognitive thinking, thinking about achieving the goal, and social support.

➤ Academic flexibility: The percentage of test anxiety increases with a decrease in academic flexibility, which makes students suffer academically more than others. Therefore, the institution and the home should be aware of these challenges and find ways to mitigate them with moral and material support and resources, which helps the students overcome anxiety in tests and achieve better results.

This study explores ways to understand the impact of academic flexibility and test anxiety on student achievement by applying a mathematical model based on machine learning and neural networks. The study also sheds light on understanding the personal and academic factors that affect achievement and academic performance, analyzing them using mathematical models, and extracting the relationship that links the model variables to develop strategic plans to improve academic performance.

2. LITERATURE SURVEY

The comparison between traditional and modern methods like machine learning will increase the capabilities for analyzing large datasets and determining the complex relationships between the different variables. Also, enhance the accuracy of feature selection, handle missing or unseen data, and generalization of results. Using machine learning in survey research is therefore a powerful and valuable tool for gaining meaningful insights and informing decision-making. Several studies discussed and investigated the relationship between test anxiety and academic motivation as mediation to enhance the student performance. Fatih and Dadadi [8] examined the relationship between academic self-efficacy and performance based on test anxiety and academic motivation as mediation tools. They tested a sample of 387 high-school students in Trabzon, Turkey, divided into 201 males and 186 females. The results show statistically significant correlations between academic motivation and test anxiety, affecting the relationship between self-efficacy and academic performance. It is widely recognized that nursing is a challenging profession, which is why nursing students receive rigorous training to prepare themselves for it. A study by Robson et al. Anxiety can be controlled, and self-efficacy beliefs regulate motivation and behavior. Self-efficacy theory and research have significantly contributed to studying and understanding human motivation. Research has shown that motivational outcomes and achievement are strongly influenced by self-efficacy [9]. The study in [10] explored test anxiety in primary schools,

specifically among children aged 5-12. The researchers reviewed 76 research papers and found that girls in Asian samples experienced higher levels of test anxiety than boys and European and North American models. The study suggests conducting more experimental studies to reduce test anxiety among primary school children. During 2020 to 2022, the COVID-19 pandemic affected older adults, healthcare providers, and people with underlying health conditions. The COVID-19 pandemic caused considerable fear, worry, and concern among the global population, according to World Health Organization. A study on anxiety and meaning in life, as well as self-efficacy and resilience, was conducted in Greece in the aftermath of the COVID-19 pandemic to examine emotions, self-efficacy, and resilience of university students from families with SEND [11]. Several studies have reported that nursing students feel depressed [12-13]. Nursing students' perceptions of stress have a significant impact on their mental health outcomes. Academic performance and general well-being can be affected by nursing students' perception of stress. In nursing students, stress can contribute to anxiety and depression, as well as the disruption of mental health and physiological function [14, 15]. Some students may even experience suicidal thoughts as a result of stress. Luo [16] discussed the effect of Self-compassion in reducing anxiety and depression among nursing students. They proposed a machine learning model based on structural equation modeling (SEM) to examine the relationship between the factors like self-compassion, perceived stress and anxiety, and depression. The datasets consist of 1453 students in nursing studies located in Ningbo, China. The results show that self-compassion helps decrease students' anxiety and depression under stress.

Devi [17], nursing students are at a high risk of experiencing stress, depression, and anxiety, which can negatively impact their academic performance and overall well-being. In psychological terms, resilience refers to the ability to handle stressful situations and bounce back from them. In order to understand whether resilience can channel stress, depression, and anxiety among nursing students in Indonesia, it is crucial to understand whether resilience can mediate the relationship between these three variables. Academic performance and self-efficacy can be impacted significantly by students' high levels of stress. It is essential for university students to build self-efficacy while managing stress in order to succeed academically. Building self-efficacy is a crucial component of academic success. In order to improve self-efficacy and overcome challenges, students should set realistic goals, focus on the process, adopt a growth mindset, seek support, and take good care of their physical and mental health. Hitches [18] shows that academic self-efficacy is one of the most crucial college success predictors in their study conducted in Australia on 305 university students. The findings suggest that stress can undermine this ability. Self-care activities and exercise help students cope with stress and maintain a positive attitude. Therefore, to build and maintain self-efficacy, universities must provide the needed skills and resources to support students under stress. According to Salimi [19], It is possible that students with a mastery and performance avoidance goal orientation may experience anxiety when learning in this context. Students who focus on avoiding mistakes are considered mastery avoidance learners, whereas those who strive for performance avoidance learners are considered performance avoidance learners. Students who are interested in mastery and performance can be helped by teachers'

motivational discourse to reduce anxiety. In order to foster learning and reduce anxiety for these learners, teachers should emphasize effort over ability, promote a growth mindset, provide constructive feedback, and promote collaboration. Academic performance can be affected by resilience and self-efficacy in adolescence. In contrast to self-efficacy, resilience refers to the ability to overcome challenges and bounce back after adversity. Resilience plays an important role in affecting academic performance in adolescence as self-efficacy mediates the relationship. Academic performance in adolescence is mediated by self-efficacy. Supervia [20] suggested a mathematical model showing that self-efficacy and resilience play an essential role in explaining adolescent academic performance. A key aspect of supporting adolescents' academic success is promoting self-efficacy and resilience. Students' academic performance may be enhanced if educators and parents provide these needed skills and strategies. In adolescents who are resilient, self-efficacy beliefs may be more likely, which ultimately results in improved academic performance through improved motivation, effort, and skills. To achieve academic success in adolescence, both resilience and self-efficacy must be fostered [20]. Prinz et al. proposed an imagery-based treatment to examine the test anxiety. They found that the quality of the imagery worked with session efficacy [21, 22]. This study seeks to identify effective strategies for reducing test anxiety, to investigate the impact of self-efficacy on achievement, to investigate how self-efficacy, test anxiety, and academic resilience relate, and to develop predictive models that predict and simulate these behaviors. The goal of these efforts is to enhance understanding and support improvements in student outcomes. Results and findings from studies on test anxiety, self-efficacy, and academic resilience are summarized in Table 1.

Table 1: summarizes studies results and findings on test anxiety, self-efficacy and academic resilience

Authors	Country	Sample Size	Factors of comparison	Findings
Supervia [20]	Spain	2652 students	Academic performance was positively related to self-efficacy and resilience.	Self-efficacy and resilience play an essential role in explaining academic performance in adolescence. A key aspect of supporting adolescents' academic success is promoting self-efficacy and resilience. Student's academic performance and overall well-being may be enhanced if educators and parents provide these skills and strategies.
Salimi [19]	Iran	89 students	Mastery orientation, learners who focused on performance avoidance had higher levels of anxiety.	Academic purpose (EAP) learners, regardless of their goal orientation, can reduce anxiety levels through teacher supportive motivational discourse. To help reduce anxiety and improve learning outcomes, teachers are recommended to provide a supportive, motivating environment for their students.
Hitches [18]	Australia	305 university students	Academic self-efficacy was negatively impacted by stress, with higher levels of stress	Academic self-efficacy is one of the most important predictors of success in college. The findings shows that stress can undermine this ability. Self-care activities and exercise can help students cope with stress and maintain a positive attitude.

			leading to lower levels.	
Devi [17]	Indonesian	336 nursing students	|Nursing students facing more stress and higher levels of depression and anxiety. Resilience is impacted stress-anxiety.	Researchers suggest resilience can buffer the adverse effects of stress on mental health outcomes such as depression and anxiety. To support the well-being of their students, nursing schools might consider integrating resilience training into their curricula. Problem-solving, emotion regulation, and positive thinking are some skills developed in resilience training to deal with stress and adversity.
Luo [16]	China	1453 nursing students	Self-compassion helps decrease students' anxiety and depression under stress.	Nursing students can manage their stress and prevent anxiety and depression by practicing self-compassion. It has been proven that self-compassion has numerous benefits for mental health, such as kindness, understanding, and acceptance. Self-compassion training may be incorporated into nursing schools to support students.
Van der Riet [15]	Australia	14 undergraduate nursing students	Stress levels of the students decreased and their ability to manage stress improved.	A stress management and mindfulness program were implemented in the study, and several lessons were learned. Three important lessons were learned: the need for ongoing support, the importance of program evaluation, and the importance of flexibility in programs. The study suggests that such programs can help students feel more connected, reduce stress, and improve well-being.
Kulsoom [14]	Saudi Arabia	575 medical students	The medical students are highly stressed, anxious, and depressed. The female medical students were more stressed, anxious, and depressed than their male counterparts.	Factors associated with stress, anxiety, and depression among medical students are Academic workload, financial burden, sleep deprivation, and lack of social support. 56.7% of participants reported symptoms of stress, 60.5% reported symptoms of anxiety, and 45.5% reported symptoms of depression. Female medical students were more stressed, anxious, and depressed than their male counterparts.
Cheung [13]	Hong Kong	661 nursing students	High prevalence of depression, anxiety, and stress among nursing students.	The study found that nursing students in Hong Kong suffer from depression, anxiety, and stress symptoms. 43.1% suffer from depression, 61.9% suffer from anxiety, and 60.8% suffer from stress. Female nursing students experienced higher levels of anxiety, stress, and depression. It is recommended that interventions should reduce the academic workload among nursing students, provide financial support, and promote social support.
Papazisis [12]	Brazilian	169 undergraduate nursing students	Self-esteem partially mediates anxiety and depression's relationship with	Religious and spiritual beliefs are positively correlated with self-esteem among nursing students. Moreover, religious and spiritual beliefs were negatively related to anxiety and depression. They indicate that religious and

			religious and spiritual beliefs.	spiritual beliefs may protect nursing students from adverse mental health outcomes
Tsibidaki [11]	Greece	61 parents and caregivers of individuals with special educational needs and disability	The levels of anxiety were negatively related to meaning in life, self-efficacy, and resilience.	The COVID-19 pandemic has negatively impacted the mental well-being of families and children with special educational needs. The article illustrates the importance of supporting and empowering these families to facilitate their resilience and self-efficacy to alleviate anxiety and improve outcomes. Healthcare providers and community organizations should develop tailored interventions to support families and students during the crisis by considering their unique needs.
Fatih [8]	Turkey	387 high-school students	Significant correlations between academic motivation and test anxiety.	The results show statistically significant correlations between academic motivation and test anxiety, affecting the relationship between self-efficacy and academic performance.

3. RESEARCH METHODOLOGY

This manuscript deployed qualitative and quantitative research methodologies to analyze and examine the relationship among self-efficacy, test anxiety, and academic resilience. The qualitative data were computed and compared using SPSS software version 25. The fully connected feedforward Multilayer perceptron network examines and measures the relationship between the quantitative data (input datasets and their target). The qualitative data were collected using a well-structured questionnaire distributed online using Google forms. The examination of the independent and dependent variables for test anxiety is shown in Table 2. In order to analyze how self-efficacy and test anxiety affect academic performance, it is important to establish the independent and dependent variables when conducting a neural network analysis. The input Variables (independent variables) for the neural network model will be Self-Efficacy and Test Anxiety. The output is an academic achievement (dependent variable), representing the outcome of interest. The proposed model is based on neural networks to simulate the proposed problem. Independent variables were designated self-efficacy and anxiety tests as input variables to the model to measure academic achievement as an independent variable (output variable). Academic achievement is performance to obtain academic excellence, such as higher marks. Self-efficacy is the student's belief in his abilities to succeed and excel academically. Some variables reduce the percentage of academic achievement, including anxiety or fear when exams, and exposure to psychological distress that is an obstacle to providing the best academic achievement. Therefore, there is a need to discuss and analyze the effect of anxiety on academic achievement, its relationship to self-efficacy, and how it will affect curbing test anxiety and raising academic achievement or vice versa. The examination of the independent and dependent variables for test anxiety is shown in Table 2. In order to analyze how self-efficacy and test anxiety affect academic performance, it is important to establish the independent and dependent variables when conducting a neural network analysis. The input Variables (independent variables) for the neural network model will be Self-Efficacy and Test Anxiety. The output is an academic achievement (dependent variable), representing the outcome of interest.

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Figure 1: Relationship between test anxiety, and academic resilience

The analytical results will help decision-makers and institution managers develop effective strategies and practical solutions to reduce the effects of exam anxiety. This will help the student to achieve the highest achievement and improves the academic results of students. Therefore, the current study seeks to explore and analyze the effect of the relationship between self-efficacy and test anxiety on the student's academic achievement through a mathematical model based on the concept of a neural network as it simulates the human mind by addressing such a relationship. In order to implement the objectives of the study, the following two research questions will be addressed:

1) What is the relationship between self-efficacy and test anxiety and its impact on academic achievement?

2) How can mathematical models through machine learning identify the variables that affect raising the percentage of academic achievement?

Table 2: Independent and dependent variables to examine the test anxiety

Independent variables	Dependent variables
TA1: *I have visible signs of nervousness (sweaty palms, shaky Hands, etc.) on right before a test*	AR1: My goal is to stop thinking negatively.
TA2: *Does anxiety in the test affect your performance in the test?*	AR2: I would set a plan to achieve my goals.
TA3: *Exam anxiety makes it difficult to focus on the exam and perform properly.*	AR3: I would self-impose rewards and punishments depending on my performance.
TA4: *Does exam anxiety hinder focus on the exam, which negatively affects performance?*	AR4: I would probably get depressed because of the stress.
TA5: *Exam anxiety continues with me even after the end of it, and I cannot forget or stop it.*	AR5: I would start to monitor and evaluate my achievements and effort.

TA6: *It is hard for me to sleep the night before the test*	
TA7: *Some students are more nervous than others during exams, affecting their performance.*	
TA8: *Anxiety makes me feel unable to answer the questions when I read them.*	
TA9: *Feel worried before and during the exam.*	
TA10: *Consistently, I remembered past reactions while preparing for a test.*	

4. MACHINE LEARNING DESIGN

Many models of neural networks, including single-layer or multi-layer networks, exist. Since this study aims to study multiple variables that affect the current problem system, a multi-layer neural network (MLP) that provides learning of complex patterns has a great potential to elucidate the relationship between the processed data. Therefore, MLP is applied to measure and analyze the effect of self-efficacy and test anxiety on student achievement. MLP is a powerful tool for extracting insights and understanding the underlying patterns and dynamics in survey data, its deployed to examine the relationship between test anxiety and academic achievement. MLPs are often used in data classification applications and forecasting rates of future outcomes, so MLP is applied to analyze data accurately for medical conditions and mental disorders. [23]. MLP consists of multiple interconnected layers of neurons from input to output and is interconnected by hidden layers. The input layers are used to enter the data and convert it into digital data based on calculating the weight for each variable and transferring the data to the hidden layers after obtaining the necessary activation value after a series of calculations to reach the highest weight value. In contrast, the output layer helps to display the final information after the end of training to obtain the classifications of the last changes or values of the regressions [24]. Each neural layer in the MLP has input variables, and each input variable has a self-calculated or randomly assigned weight. Through the learning process, the values of the weights are updated. In order to finish training the network, we need a specific learning algorithm. The most popular is the backpropagation algorithm which adjusts the weights of each input by calculating the gradient of the loss function and updates it accordingly [25]. Iterative training of variables in MLP allows us to improve the network's performance and make accurate predictions based on the input data representing the actual experiment values. In order to perform well with the computation model, we have to use a large amount of data in simulating the experiment data, which is computationally expensive.

One of the advantages of using an MLP neural network is to train on fewer data to reduce computational costs. Therefore, the study aims to take advantage of the ability of the multi-layered neural network model to capture the complex relationships between the input variables, such as self-efficacy and test anxiety, and the output variable, such as academic achievement. One of the expected results of the study is to provide an analysis and calculation of the relationship between self-efficacy, test anxiety, and the student's academic achievement percentage. This contributes to the development of systems and strategies to support students in managing and overcoming test anxiety and enhance self-efficacy to reduce anxiety, thus improving student academic results. The current

experiment used an MLP neural network with ten input layers, one hidden layer, and five output layers based on the current problem data. The present network has implemented hyperbolic tangent arithmetic ("tanh") as an activation function in order to compute the nonlinear value of set input values within a range of -1 to 1. "tanh" is a symmetric function with equal positive and negative values around zero that helps avoid computation bias. The sum of squares function is used to measure the error of the calculation. The data was divided into two parts to develop the machine learning model: the training sets to complete the training of the network and the test sets to evaluate the model's performance. In this experiment, the data set was divided into 67.8% (179) of the total data for the training set, and the remaining 32.2% (85) is for the test set. The MLP topology is illustrated in Figure 2.
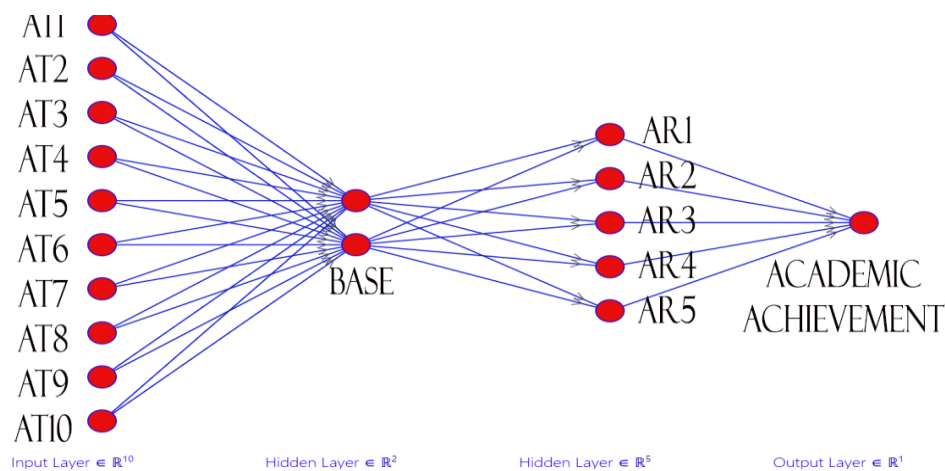

Figure 2: proposed MLP topology

To accurately fill one of the research gaps for capturing complex nonlinear relationships between variables. This research utilizes MLP to explore the relationship between academic resilience, test anxiety, and its impact on academic achievement. However, traditional statistical methods use solve-to-linear relationships, and on the other hand, MLP can simulate complex and nonlinear relationships between variables. The benefits of MLP models are that they can learn and train even in cases of fewer nonlinear patterns. This is particularly relevant when studying psychological concepts like academic resilience and test anxiety, which exhibit nonlinear and dynamic patterns. Besides, the MLP model can quickly learn relations between features data, such as academic resilience, test anxiety, and academic achievement. Finally, MLP models have demonstrated strong predictive capabilities in various domains, achieving high prediction accuracy that can accurately forecast academic achievement based on academic resilience and test anxiety variables.

The network output is computed as in equation (1).

$$W - net = \sum_{i=1}^{n} w_i * x_i \tag{1}$$

where x_i is the input vector to the network and w_i is the weight of each input i.

The backpropagation learning algorithm (BP) is utilized to adjust errors across network layers and modify weights in the hidden layer. The computation of the BP learning function is defined as in equation (2)

$$E(w) = \sum_{p=1}^{pt} \sum_{i=1}^{epoch} (di(p) - yi(p))^2 \tag{2}$$

where E (w) is the error function, w is the weight vector. di(p) is desired output of neuron I and yi(p) is experimental output of the neuron i.

The weight is computed as in equation (3):

$$Wij(n+1) = Wij(n) + \eta\delta i(n) + xj(n) \tag{3}$$

Where the $\delta i(n)$s is the computed local error based $Wij(n)$ using step size is η.

The hyperbolic tangent function, commonly denoted as "tanh(x)", is given as in equation (4):

$$\tanh(x) = (e^x - e^{(-x)})/(e^x + e^{(-x)}) \tag{4}$$

The equation uses "e" to represent Euler's number, approximately 2.71828. The hyperbolic tangent function converts any real number input "x" into a value between -1 and 1, creating a sigmoid curve. This curve is symmetric around the origin (0,0) and approaches -1 as "x" gets closer to negative infinity and approaches 1 as "x" gets closer to positive infinity.

5. RESULTS AND DISCUSSION

This section demonstrates the application of the proposed method based on the machine learning model using multilayer neural networks (MLP) to test the effect of factors of academic flexibility and exam anxiety on academic achievement. The neuronal model (MLP) was applied because it is an effective method for learning complex patterns, analyzing them, and predicting the results accurately because of its ability to classify factors according to their importance in the model. The results of the study are discussed and analyzed statistically to ensure the validity of the data and to extract patterns of relationships later. Then we discuss the results of applying the MLP multilayer neural model to test students' academic achievement based on the inputs of the value of academic flexibility and test anxiety. In order to collect the necessary data for the research, a questionnaire was created and distributed online to a sample of students containing a set of questions to calculate the relationship between academic flexibility, test anxiety, and academic achievement. The statistical results showed the strength of the correlation between the input and the output variables.

5.1. Data collection

The study used data collected through a questionnaire distributed online to students. The validity and accuracy of the data and the relationships between the variables were tested by applying different statistical techniques using SPSS, such as correlation analysis and regression [26]. This data underwent a comprehensive and rigorous cleaning and filtering

process to ensure data quality and suitability for the study. The reconfiguration steps included repairing structural errors, cleaning, removing duplicate or incomplete data that is missing part of the necessary information or missing data sets, and deleting unwanted data sets. The questionnaire was distributed to a group of students with more than 400 participants who answered the questionnaire questions correctly and accurately according to their perceptions and their consent to participate in the questionnaire voluntarily. After cleaning the data and isolating the defective ones, we obtained only 264 participants who met the study requirements and were included in the final clean, high-quality data set that provided reliable and accurate information for the study and contributed to producing accurate results.

5.2. Statistical Results

Various statistical methods are used in analyzing data and examining the relationship and distribution of variables, such as mean, median, and mode. It can provide helpful information about the average value of the data and center point [27].

The mean of the datasets is the sum of all the values (x_i) divided by the total number of data (n) as represented in equation (5).

$$\text{Mean}(\mu) = \sum_{i=1}^{n}(x_i)/n \tag{5}$$

The Median determines the middle value by arranging the dataset in ascending or descending order. If the total number of data is even, then the Median is the arithmetic mean of the two middle values. Standard deviation describes measures of the distribution of a dataset comparable to its mean, which is calculated by the equation (6)

$$\text{Standard Deviation }(\sigma) = \sqrt{\text{Variance}(\sigma^2)} \tag{6}$$

The Variance determines the average of the squared data differences from the arithmetic mean. It is calculated as in the equation (7).

$$\text{Variance}(\sigma^2) = (\sum_{i=1}^{n}(x_i - \mu)^2)/n \tag{7}$$

The results of this study show that the mean value is 3.51 and the median value is 4, which indicates that the data tend to cluster. The values of standard deviation and variance are 1.14 and 1.3, respectively. Skewness measures the asymmetry of the data, which is equal to 0.15. Moreover, the kurtosis measures the peak degree of the data, which is equal to -0.125—finally, determining the minimum and maximum values equal to 1 and 5, respectively. The results full results are depicted in Table 3 and also presented in Figure 3. Additionally, the results show that the mean value is identical to the median value, which indicates that the data are relatively symmetrical distributed—this symmetry of data help to enhance the accuracy of central tendency representation, simplifying data interpretation.

5.3. Neural Network Model Results

This experiment includes five factors to describe academic resilience toward reaching the objectives of this study. The first factor is AR1, which highlights the importance of keeping a positive attitude and stopping negative thinking with a rate of importance equal to 0.997.

This factor is one of the most critical factors for success because negative thoughts can increase self-doubt and low self-efficacy, which hinder academic achievement. The next factor is AR2, which emphasizes the importance of a well-thought-out strategy to achieve the objective. Table 4 shows the results of the MLP Model Summary with 1000 epochs. The AR2 is a crucial factor that shows the need for students to make a plan to achieve their goals.

Table 3: Statistics descriptive results

		Gender	Age	TA1	TA2	TA3	TA4	TA5	TA6	TA7	TA8	TA9	TA10
N	Valid	264	264	264	264	264	264	264	264	264	264	264	264
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean				3.51	4.05	4.31	3.67	3.54	3.61	3.65	3.64	3.65	3.39
Median				4	4	5	4	4	4	4	4	4	3
Std. Deviation				1.14	1.081	0.952	0.957	1.266	1.298	1.346	1.193	1.17	1.119
Variance				1.3	1.169	0.907	0.915	1.603	1.684	1.811	1.424	1.369	1.251
Skewness				-0.546	-1.073	-1.323	-0.156	-0.525	-0.633	-0.639	-0.46	-0.614	-0.331
Std. Error of Skewness				0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Kurtosis				-0.125	0.61	1.061	-0.587	-0.726	-0.645	-0.773	-0.671	-0.326	-0.51
Std. Error of Kurtosis				0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299
Minimum				1	1	1	1	1	1	1	1	1	1
Maximum				5	5	5	5	5	5	5	5	5	5

The results show it is a crucial factor based on the important rate, which equals 0.981. Also, the third factor AR3 is crucial based on the important rate, which equals 0.980. Besides the fourth factor, AR4 indicates the negative impact of stress on increasing depression with an important rate equal to 0.779. Finally, the AR5 factor indicates that the students are willing to adjust their plan to achieve their goal, with a value of importance equal to 0.996. These five factors reflect a mindset of determination, self-awareness, and adaptability crucial for success in any endeavor.
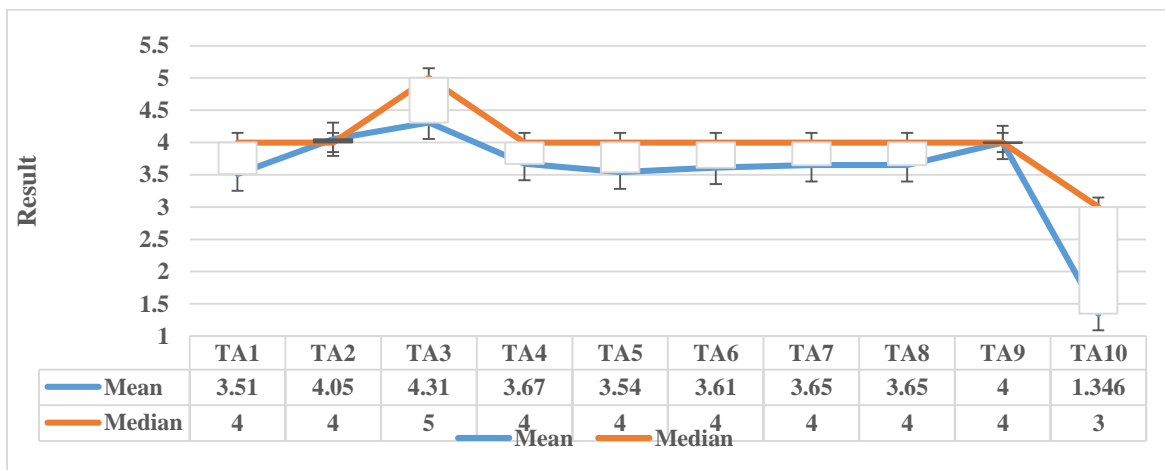

	TA1	TA2	TA3	TA4	TA5	TA6	TA7	TA8	TA9	TA10
Mean	3.51	4.05	4.31	3.67	3.54	3.61	3.65	3.65	4	1.346
Median	4	4	5	4	4	4	4	4	4	3

Figure 3: Statistics descriptive results

To answer the first research question "RQ1: What is the relationship between self-efficacy and test anxiety and its impact on academic achievement?"

The results of the neural network model related to testing anxiety and how it affects individuals' performance before and during an exam. The first factor, AT1, describes

visible signs of nervousness, such as sweaty palms and shaky hands, before a test, considered moderate with an important rate of 0.146. The second factor, AT7 factor states that some students are more prone to nervousness during exams, which ultimately affects their performance with rate of 0.126. The third factor is AT10, describes how past experiences can affect an individual's preparation and readiness for an upcoming test, and it has a moderate importance rate of 0.122. The factor, AT6, highlights how difficult it is for some individuals to sleep the night before a test due to anxiety. It has a lower importance rate than the others (AT1, AT7, and AT10). Also, the factor, AT8, presents the impact of anxiety to make student feel unable to answer the questions when read them. It has a lower importance rate than the others (AT1, AT7, and AT10). The factors (AT2, AT3, AT4, AT5, AT6, and AT9) are the less impactful and important on the student achievement.

Table 4: MLP Model Summary with 1000 epochs

Training	Sum of Squares Error		106.997
	Average Overall Relative Error		.716
	Relative Error for Scale Dependents	My goal is to stop thinking negatively.	.715
		I would set a plan to achieve my goals.	.679
		I would self-impose rewards and punishments depending on my performance.	.732
		I would probably get depressed because of the stress.	.678
		I would start to monitor and evaluate my achievements and effort.	.808
	Training Time		0:00:00.02
Testing	Sum of Squares Error		50.138
	Average Overall Relative Error		.940
	Relative Error for Scale Dependents	My goal is to stop thinking negatively.	.997
		I would set a plan to achieve my goals.	.981
		I would self-impose rewards and punishments depending on my performance.	.980
		I would probably get depressed because of the stress.	.779
		I would start to monitor and evaluate my achievements and effort.	.996

Finally, Overall, these results shed light on how test anxiety can manifest itself and affect academic achievement. Utilizing different numbers of epochs in the experiments when training an MLP neural network model can provide several benefits, allowing researchers to assess the model's performance and optimize its learning process. We implemented different numbers of epochs in MLP neural network experiments, which offers valuable insights into the model's performance, convergence, generalization, and stability. This helped us optimize the training time, avoid overfitting, and fine-tune the hyperparameters. It is important to note that the optimal number of epochs can vary depending on the dataset's complexity, size, and the complexity of the modeled relationships. In some cases, increasing the number of epochs beyond a certain point can lead to overfitting, where the model becomes too specialized in the training data and fails to generalize well to new, unseen data. Therefore, finding the right balance is crucial, and it often requires experimentation and validation techniques such as cross-validation to identify the optimal number of epochs for a specific problem.

Our results in Table 5 demonstrate that selecting the appropriate number of epochs can significantly enhance the model's performance and ensure its ability to identify the most impactful factors accurately. The first experiment had unstable and inconsistent results

when 10 epochs were used as shown in Figure 4. This was due to the neural network's node weights not having enough time to adjust and accurately reflect the patterns in the data. During training, the neural network updates its weights to minimize the difference between predicted outputs and actual targets. A limited number of epochs caused the model to require more iterations to converge and reach an optimal solution. Increasing the number of epochs gives the model more training time to fine-tune its weights and improve its ability to recognize patterns. This iterative process allows the neural network to adjust its parameters more accurately and align them with the desired data representation. Consequently, the model becomes more stable and consistent in its predictions, producing more reliable and robust results.

Table 5: Independent Variable Importance

Importance/ #Epochs	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10
10	.108	.098	.087	.062	.069	**.139**	**.133**	**.146**	.078	.081
50	**.144**	.077	.084	.092	.080	.113	**.125**	.111	.058	**.117**
100	**.131**	.076	.091	.084	.087	.106	**.124**	.091	.082	**.117**
1000	**.146**	.091	.085	.073	053	.087	**.126**	.121	.096	**.122**

TA1: I have visible signs of nervousness (sweaty palms, shaky Hands, etc.) on right before a test

TA2: Does anxiety in the test affect your performance in the test?

TA3: Exam anxiety makes it difficult to focus on the exam and perform properly.

TA4: Does exam anxiety hinder focus on the exam, which negatively affects performance?

TA5: Exam anxiety continues with me even after the end of it, and I cannot forget or stop it.

TA6: It is hard for me to sleep the night before the test

TA7: Some students are more nervous than others during exams, affecting their performance.

TA8: Anxiety makes me feel unable to answer the questions when I read them.

TA9: Feel worried before and during the exam.

TA10: Consistently, I remembered past reactions while preparing for a test.

RQ2: How can mathematical models through machine learning identify the variables that affect raising the percentage of academic achievement?

Using a machine learning approach called Multilayer Perceptron (MLP), we aimed to identify distinct patterns in academic resilience and test anxiety factors that affect academic achievement in different student groups. Specifically, we focused on two groups: Group 1, which comprises students who are nervous during exams, and Group 2, consisting of students who have experienced past exam reactions.

Based on these considerations, we can conclude that the factor AT1: " I have visible signs of nervousness (sweaty palms, shaky Hands, etc.) on right before a test ", significantly impacts academic achievement. Test anxiety can hinder students' academic progress by reducing their ability to perform their fullest potential during exams. It is follows by the factor AT7: "Some students are more nervous than others during exams, affecting their performance," mainly impacts academic achievement. While the factor "AT10: Consistently, I remembered past reactions while preparing for a test" can provide insight into the impact of past experiences on students' test preparation and performance, it

should be used in conjunction with other measures to provide a comprehensive understanding of the factors that influence academic achievement.

Our findings can inform educators and policymakers in developing targeted interventions that cater to the unique needs of these student populations and lead to improved academic outcomes.

Based on the MLP results after 1000 epochs, Figure 5 displays the importance variable level. It is evident that AT1, AT7, AT10, and AT8 are the most significant impact factors.

Mathematical prediction models help people make better decisions, anticipate future outcomes more efficiently, understand relationships, and optimize processes. These tools are valuable for decision-makers and researchers in various fields. A polynomial model is a mathematical equation that shows the relationship between an independent variable ('x') and a dependent variable ('y') using polynomial terms. These terms are obtained by multiplying the powers of the independent variable by coefficients. Polynomial models are a powerful tool for predicting experimental data, especially when the relationship between variables is nonlinear [28].

Our model uses the sixth degree of the polynomial to make effective predictions and gain insight from experimental data. The coefficient of determination, R^2, is a statistical measure that shows the proportion of the variance in the dependent variable (y) explained by the model's independent variable (x). Figure 6 shows that the value of 1 for R^2 indicates a perfect fit, meaning that the independent variable accounts for most of the variance in the dependent variable.

Predicting experimental data in advance for 5 or 10 years is crucial because it may provide several advantages, including strategic planning, long-term analysis and implementation, and accurate decision-making. However, it is necessary to clarify that the prediction of empirical data for future years is approximate values that may include errors due to rounding or cutting the results of calculations such as division and multiplication. Such unanticipated mathematical errors may cause future events and conditions to deviate from original expectations or results.
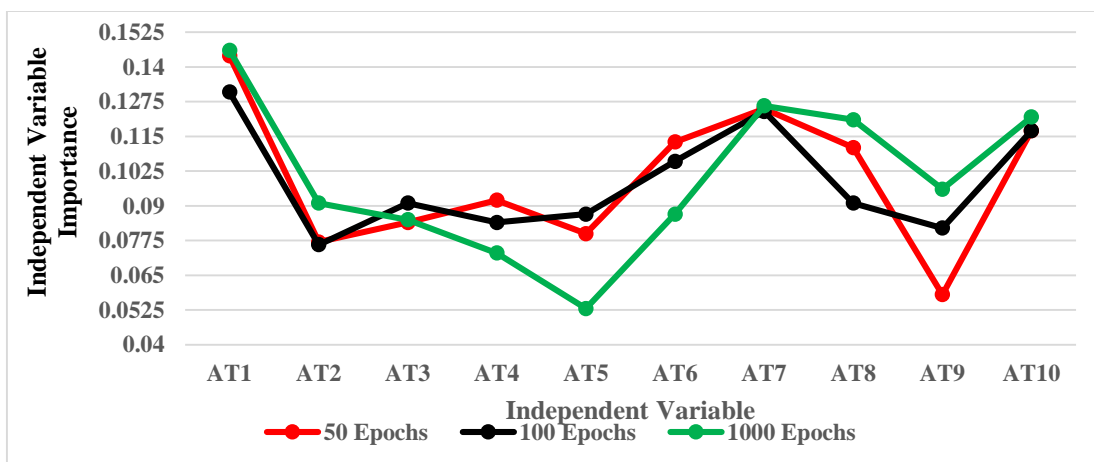

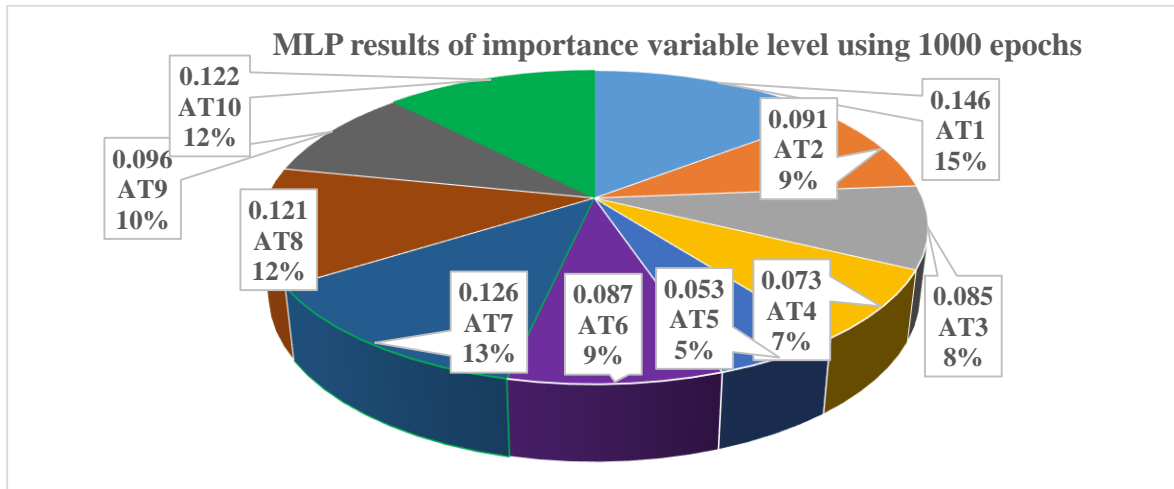**Figure 4: MLP results of importance variable level for (50,100,1000) epochs**

Figure 5: MLP results of importance variable level using 1000 epochs

$$y = 0.0125x^5 - 0.2117x^4 + 1.333x^3 - 3.8378x^2 + 4.965x - 2.106$$
$$R^2 = 1$$

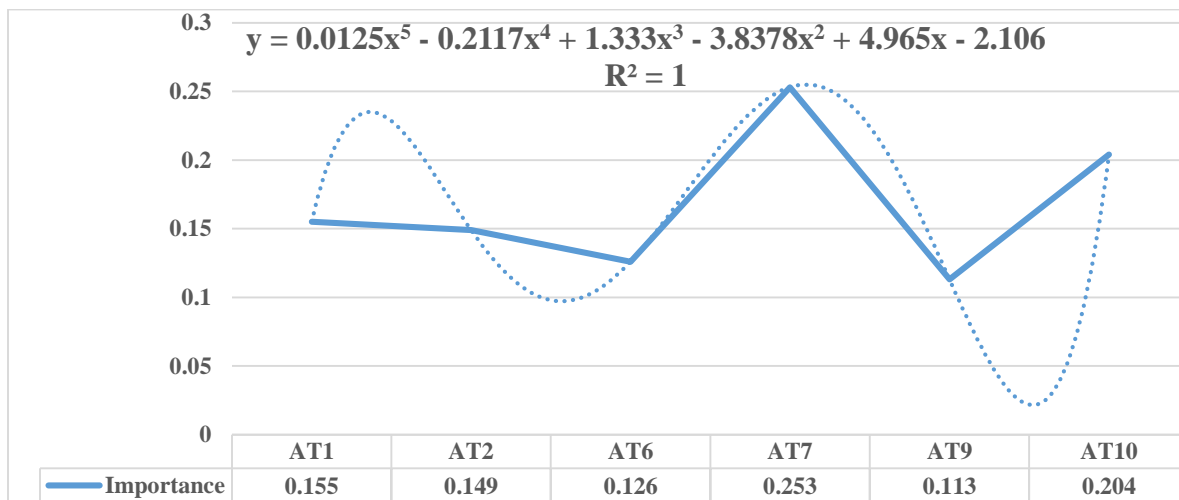|	AT1	AT2	AT6	AT7	AT9	AT10
Importance	0.155	0.149	0.126	0.253	0.113	0.204

Figure 6: Polynomial models of fifth degree

Figure 7 shows that the future prediction of self-test anxiety increased by 300% in the next 5 years, affecting academic achievement. Therefore, the students who get more nervous during exams will be more affected by test anxiety based on the results of the factor (AT7). Additionally, the study indicates that the student's bad past experiences with testing may impact a student's preparation for the current exam and affect overall performance based on the result of the factor (AT10).
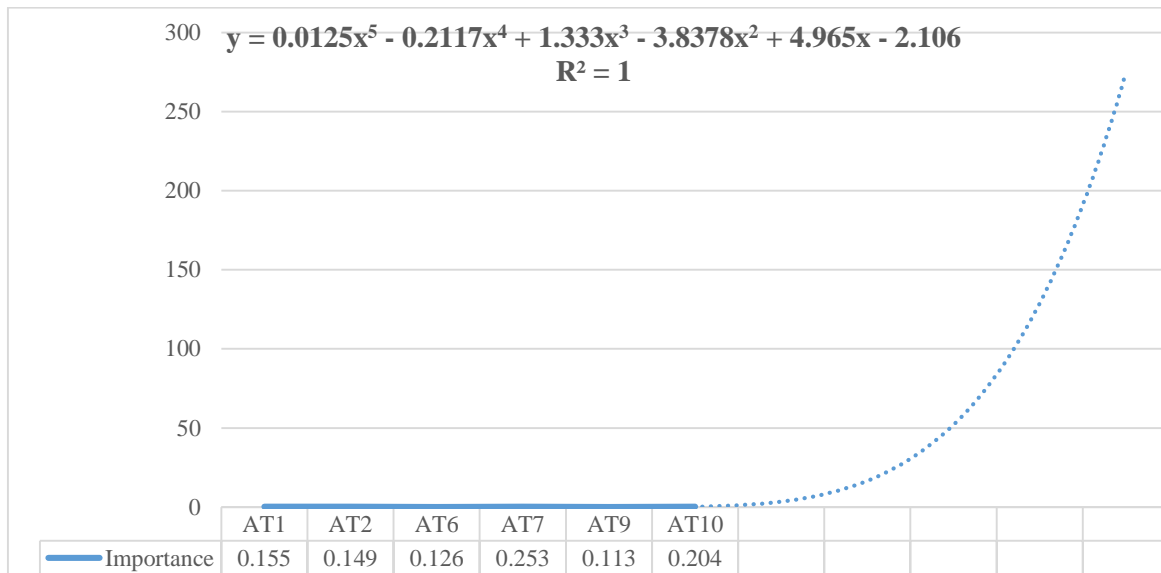
The chart displays the equation:

$$y = 0.0125x^5 - 0.2117x^4 + 1.333x^3 - 3.8378x^2 + 4.965x - 2.106$$
$$R^2 = 1$$

	AT1	AT2	AT6	AT7	AT9	AT10
Importance	0.155	0.149	0.126	0.253	0.113	0.204

Figure 7: The Prediction models of future figures

6. CONCLUSION

This study utilized a machine learning method based on multi-layer perceptrons (MLPs). The study identified five crucial factors for achieving goals: having a positive mindset, a well-thought-out plan, being accountable for progress, acknowledging potential stress and negative emotions, and monitoring and evaluating one's achievements and efforts. These five factors reflect a philosophy of determination, self-awareness, and flexibility crucial for enhancing the student achievement. The results showed that having a positive mindset (AR1) was the most important factor for success, with an important rate of 0.997. Monitoring and evaluating one's achievements (AR5) and a well-thought-out plan (AR2) were also essential factors, with important rates of 0.996 and 0.981, respectively. The results highlight that Academic Resilience is an important factor in keeping a positive attitude and stopping negative thinking, with a rate of importance equal to 0.997. Also, the well-thought-out strategy to achieve the objective is helping to increase academic achievement. Different epochs were implemented to enhance the results of the MLP Model, which indicates that the use of 1000 epochs obtained the best accuracy. Five factors related to test anxiety and academic achievement were also identified, with AT1 indicating that visible signs of nervousness (sweaty palms, shaky hands, etc.) before a test mainly impact academic achievement with a rate of 0.146. Meanwhile, AT7 stated that some students are more prone to nervousness during exams, ultimately affecting their performance, with an important rate of 0.126. The study used machine learning to identify distinct patterns in academic resilience and test anxiety factors that affect academic achievement in different student groups. The results can guide educators and policymakers in developing targeted interventions that cater to the unique needs of these student populations and ultimately lead to improved academic outcomes. The study uses machine learning algorithms to investigate the relationship between self-efficacy, test anxiety and their impact on the academic achievement. The study also identified distinct

patterns in academic resilience and test anxiety factors that affect academic achievement in different student groups. The findings can inform educators and policymakers in developing targeted interventions that cater to the unique needs of these student populations and lead to improved academic outcomes. A prediction model has been created to forecast the relevant data and analyze future conditions.

However, the following are some of study limitations:

- First: the study sample:

In order to reach a standard and unbiased distribution of the data, we need to increase the sample size since the study included only 264 participants, which reduces the possibility of the generalizability of the results.

- Second: Geographical area:

Most of the participants in the study are from a specific population area, which reduces the possibility that the results apply to other contexts, such as the inclusion of different age groups or educational systems in different arts.

- Third: Test Scale:

The study relies heavily on measuring the effectiveness of students' self-report only, which may lead to inaccurate conclusions due to bias or wrong measurement. For example, students may not accurately disclose their anxiety about the test or what worries them before the exam due to worry or stress. Also, not involving other groups will limit the scale of the study, so we should include teachers or parents, which helps increase academic flexibility.

- Fourth: Measurement variables:

The study addressed several limited factors that may affect academic achievement, such as test anxiety and self-efficacy. At the same time, it was better to include other important factors such as social status, economic status, emotional status, learning methods, age group, parental involvement, and other variables.

For the results to be more comprehensive and general, future research must find a solution to these shortcomings to provide a more comprehensive understanding of the complex interaction between the various factors, such as social, cognitive, and emotional.

Here are some future directions of current research:

- Apply other approaches to machine learning and compare them with current results. For example, using feedback networks, decision trees, or support vector machines.

- Applying other practical approaches as inputs to improve students' self-efficacy and reduce their test anxiety, such as cognitive-behavioral therapy and academic training to increase self-confidence and improve the emotional state to be strong during crises.

- Studying how different demographic factors such as age, gender, and socioeconomic status affect the strength of the relationships between self-efficacy and test anxiety as input and academic achievement as output.

- Studying how different learning styles and factors such as self-efficacy and test anxiety affect academic achievement.

- Studying the effect of other factors such as motivation, goal setting, and study habits to raise self-efficacy, reduce test anxiety, and increase academic achievement.

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