**Stress Detection in Learning STEM Subjects Among Primary School Students by Using EEG Signal**

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**FINAL YEAR PROJECT REPORT**

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by

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In partial fulfillment of the requirement for the

Bachelor of Computer Science

Department of Computer Science

Kulliyyah of Information and Communication Technology

International Islamic University Malaysia

MONTH 2021

Semester 1 2021/2022

ACKNOWLEDGEMENTS

Praise and thanks to Allah first and foremost whose blessing enabled us to accomplish this project.

We wish to express our deepest appreciation to our supervisor Dr Norzaliza Md Nor, being one of our research supervisors, for sharing her expertise with us throughout this study. This paper would not have been completed without her support and active participation in every stage of the process. Thank you so much for your guidance and blessings over the year.

ABSTRACT

Stress in learning Science, Technology, Engineering and Mathematics (STEM) subjects has become crucial among students in Malaysia. Malaysia education Blueprint in 2020 reported that Malaysia has scored at the lower ranked in programme for international student assessment (PISA) for mathematics and science test. Thus, this research study aims to provide sufficient proof of correlation between STEM topic questions and stress levels through emotion detection during the test time. The research was conducted according to a conventional methodology for an EEG machine. Mel-Frequency Cepstral Coefficients (MFCC) will be used to extract features from the data, and MLP will be used as a classifier. The result of this study shows that, low grade students tend to have low stress level compared to medium and high-grade students. This research may benefit the students, teachers, parents to have an early detection for stress level among primary school students especially in learning STEM subjects.

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LIST OF ABBREVIATIONS

EEG Electroencephalogram

IAPS Internatonal Affective Picture System

ASM Affective Space Model

STEM Science, Technology, Engineering and Mathematics

VA Valence and Arousal

MFCC Mel-Frequency Cepstral Coefficient

MLP Multi-layer Perceptron

NN Neural Network

EO Eyes Open

EC Eyes Close

CHAPTER ONE

# INTRODUCTION

## Problem Statement

Science, technology, Engineering, and Mathematics, called STEM, are the most important subjects for students to do well in school. Unfortunately, most of the students are struggling to cope with these subjects. In 2018, 45.2% of secondary students (aged 17) in Malaysia were enrolled in STEM, however that percentage has declined to 43.7% in 2019. Student’s answers to the programmed for international student assessment (PISA) 2015 questionnaire revealed a strong desire to study science and math’s. Students expressed an interest in studying science and mathematics in their replies to the PISA 2015 questionnaire. 91.3% of 15-year-old pupils agreed that studying science is worthwhile because it would benefit them in future employment, and 91.5% felt that knowing science is essential for the future. Only 13.2% want to be scientists and engineers, 14.0% would like to be healthcare professionals, 1.3% want to be information and communication technologies professionals, and only 0.6% get to be scientific specialists when it comes to science-related professions (Nordin, 2020). STEM education does not only help students who plan to go into STEM careers. Students may establish mental habits that will help them succeed in any subject by focusing on logical thinking processes and problem solving. The problem in this research study is to find out whether a STEM subject might cause stress or not.

**1.2 Project Objective**

**1.2.1 The first objective is: Identify the level of Stress among primary school students towards STEM.**

As the primary school students tend to have the stress while they are doing STEM relates tests or exam. We need to find out how they get stressed when they are trying to solve the STEM questionnaires by make an assessment test for psychology and pattern of brain signals from EEG machine.

**1.2.2 The second objective is: Analyze the correlation between emotion and stress among primary school students by using neural networks.**

The connection might be subjective and behave differently depending on the subject while negative (-ve) emotion will indicate stress and positive (+ve) emotion indicates non-stress.

**1.3 Project Scope**

**1.4 Significance of Project**

STEM education prepares students with skills that make them more employable and equipped to meet the needs of today's workforce. It encompasses a broad variety of talents and experiences. Each STEM component plays an important role in a well-rounded education. We must change since the world we live in is changing. STEM education benefits society by instilling in students a new mindset and skills that are valued in any sector. They encourage young people to be adaptable, to seek for patterns, to make connections, and to assess information. Also, STEM education develops social awareness. It raises public awareness of global challenges, and STEM possibilities help us move to a knowledge-based economy with improved sustainability literacy. Through this research by stress detection for learning STEM subjects, it can help the students to identify their motivation and interest towards STEM subjects and help the teacher to understand more the student’s ability in learning STEM. In addition, the execution of computing techniques used can measure stress among primary school students in learning STEM.

**CHAPTER TWO**

**REVIEW OF PREVIOUS WORK**

**2.1 Stress**

Stress is defined as a personal interaction between people and their environment that is seen as challenging or surpassing coping resources (Lazarus & Richard, 1966). According to Stress and coping theory Hypotheses concerning the stress process and its relationship to physical and mental health are tested using a framework. Anger, humiliation, and anxiety are frequent stress-related emotions, suggesting a relationship between stress and emotion. Based on Lazarus and Folkman’s (1980) theory, how a person perceives (appraises) interactions with their environment determines stress and emotions. Individuals may feel significant amounts of stress when they realize something vital to them is uncontrollable throughout the examination.

Regarding the relationship between stress and negative emotions, researchers agree that they are closely related. For instance, according to some studies, depression is a kind of stress reaction. (Kiecolt-Glaser et al., 2002 & Sternberg et al., 1992). Fiedler, et al., (2005) found that Anxiety symptoms may be predicted by stress. Furthermore, according to a study of 5236 college students, the more concerned they are about their schoolwork, interpersonal relationships, and other problems, greater likely students are to display angry. Another study of 939 American teenagers discovered that people's perceived stress predicts their anger, which in turn drives their bad behavior, such as drug usage (Aseltine, Gore, & Gordon, 200). Also, in cancer patient’s stress perceptions, there was a significant positive connection between anger and depression (Lee et al., 2005).

**2.2 Science, Technology, Engineering, and Mathematics (STEM)**

The term STEM was first used in the early 1990s in the United States to describe government programs. The objective is to ensure that every person of the United States is eager to pursue Science, Technology, Engineering, and Mathematics (STEM) degrees and, as a result, be able to work in STEM-related sectors such as scientists, engineers, mathematicians, and technicians (Rosana, Kadarisman, purwanto, & Sari, 2021). Many students feel anxiety in educational environments, according to an increasing number of research in Education Science (Lehtamo, Juuti, Inkinen & Lavonen, 2018). Stress may come from a variety of places. Physics, math’s, and statistics are among the STEM topics that have been documented to induce frightened emotional states of increased attentiveness across many educational systems and levels, from primary school to college students (Siew, Mccartney, & Vitetitvh, 2019). Mallow was the first to notice this phenomenon, He also invented the phrase "science anxiety" and linked it to bad scientific performance [Mallow, 2006]. Anxiety-induced enhanced arousal inhibits students' focus on the work at hand, having a significant influence on problem solving and even information retention (Bodin & Winberg, 2012). In any school context, anxiety may come from a variety of sources.

It's important to note that personal evaluation in education is a difficult subject, with impending exams usually producing "Test anxiety," a sensation of anguish, over-arousal, and tension that is most identified before to taking an exam or a test [Nunez-Pena et al, 2013]. Cassady and Johnson showed that Moderate levels of anxiety were linked to higher academic accomplishment, but higher levels of anxiety had a detrimental influence on test performance. Science anxiety may also be caused by a lack of role models and a drab image of the topic [Lehtamo et al, 2018]. It is essential to emphasize that the emergence and intensification of anxious emotions from any of the aforementioned causes has negative consequences for children' performance in school and beyond, lowering academic success and deterring kids from pursuing jobs in science, technology, engineering, and mathematics (STEM) (Valenti, Masnick, Cox, & Osman, 2016).

**2.3 Electroencephalogram (EEG)**

Electroencephalography (EEG) is a non-invasive test that monitors electrical activity in the brain. Voltage variations within brain neurons are the cause of EEG activity. As a result, it reflects synchronized neuron activity. The EEG exhibits oscillations at various frequencies. The frequency of this rhythmic activity is separated into bands, and it is frequently linked to distinct phases of brain function (Surangsrirat & Intarapanich, 2015). These EEG signals may then be analyzed to determine the student's dynamic emotions as well as the antecedent emotion. Many researchers have used an EEG gadget to capture brain activity from the cortical surface in milliseconds. (Khosrowabadi, quek, Ang, & Wahab,2015). The differential stress inventory was validated using a probabilistic stress profiler (Anand & Kumar, 2017). The binary classifier successfully predicted 30 of the 41 cases.

**2.4 Russell’s Model**

In this research study, Russell’s model (Russell, 1980) has been adapted according to recent studies, it's important to comprehend human emotion (Yaacob, Abdul, Shaikhli, & Kamaruddin, 2014). According to psychology, there are eight primary emotions: joyful, calm, fear, sadness, anger, disgust, and surprise (Ekman, 1999). In figure 1, Russell's Affective Space Model (ASM) is a two-dimensional way to describing emotion.

Diagram

Description automatically generated

Figure 1.1 Russel’s Model of Affect

Four fundamental emotions, derived from a mix of valence and arousal, have been chosen as the foundation. Analyzing and comprehending brain waves may reveal brain activity in a dynamic method.

**2.5 Multi-layer Perceptron (MLP)**

Several machine learning classifiers were implemented to accomplish emotion classification. An average of 78.11 percent accuracy was achieved using the multilayer perceptron (MLP) as a classifier to categorize happy, love, fear, and sad (Bhatti, Majid, Anwar, & Bilal, 2016). In another study, MLP was used to distinguish happy, sad, fearful, and calm people based on their valence and arousal levels (Nor, Salleh, & Zubaidi, 2016). Emotion’s classifiers are also used to assess elementary school teachers' stress levels. In addition to that in MLP, the 12-point affective circumplex and the recalibrated speech affective space model (rSASM) are used to categorize emotion (12-PAC) (Othman et al., 2016). The accuracy of categorizing emotion using MLP based on rSASM was 78.5 percent on average, which is 14.5 percent lower than the 12-PAC model's accuracy. Based on few more researcher it has proven that to perform emotion classification multilayer perceptron (MLP) is giving better accuracy than any other machine learning classifier (Handayani et al, 2016; Palo et al, 2017).

**CHAPTER THREE**

**METHODOLOGY**

**3.1 Research protocol**

In this experiment, we used an experimental design in which we placed electrodes from an EEG machine on the individuals' heads using 19-channel guidance.  The electrode is physically placed on the subject's head using the special cap. Then we go on to the next stage of the experiment, which involves recording the subject's brain activity while their eyelids open and shut for one minute each. The experiment continues with a one-minute viewing of the International Affective Picture System (IAPS) emotion sequence pictures, which include happy, calm, sad, and frightened images, and a recording of the brain signal as it moves through the pictures.

Diagram, text

Description automatically generated

Figure 3.1 Experimental Design

After that, students read each Mathematics and science question by themselves that consist of 12 questions on easy (30 seconds), moderate (1 minute) and hard (1 minute) and being displayed on the screen to the subject. If they can, they must answer the question and record their brain signal for each of the 12 questions. Finally, before concluding our experiment, we perform and record the subject's brain signal while open eyes and closed eyes for one minute. The experimental protocol as in figure 3.

**3.2 Data Analysis**

The technique used in this experiment can be split into two important parts that must be carefully followed to get the best results for stress detection and avoid errors. Following the collection of data in the form of brain signals, mathematics, and science, additional actions are requiring technological procedures must be completed before the final result can be obtained.

The first stage is to extract the key characteristics of brain waves from the EEG machine's 19 channels. Before moving on to the next step of the process, classification, we used Mel-frequency cepstral coefficient (MFCC) to extract the features. In the second section, we employed MLP classifiers to determine whether or not the outcomes of Stem subjects for students are influenced by stress. In MATLAB, the result produced with the MLP function is simply accessible. The procedure is shown in detail in the figure below. However, for Mathematics and Science questionnaires for subjects to answer, we used that to identify the level of stress based on psychological perspective. The response for each subject can be considered as a preliminary result.

**Text

Description automatically generated**

Figure 3.2 Data Analysis Process

Following the collection of data from individuals, the data will be subjected to a procedure known as feature extraction. Feature extraction is used to simplify the dataset in order to speed up the classification process in the next step. To provide high reliability and accuracy for training the dataset, important features are retrieved using MFCC. The MLP algorithm is used to train brain signals from participants during the International Affective Picture System (IAPS) emotion sequence.

Russell's model of affects proposes that training is necessary by matching the value of arousal and valence with the appropriate kind of emotion. As seen in the figure below, Russell's model includes numerous emotions with different levels of arousal and valence.

Table 3.2 Valence arousal expected output

Table

Description automatically generated

Additional feature extracted brain signals, such as signals of shutting and opening eyelids, as well as answers to Mathematics and Science questions, will be used to test the training datasets. A displayed valence-arousal graph will eventually be used to classify the test's findings.

**CHAPTER FOUR**

**ANALYSIS OF RESULT AND OUTCOME**

**4.1 Analysis of Result**

# STEM Subject 1

Chart, line chart

Description automatically generatedSTEM subject 1 brain signals for the question 1 of Russell's model bellow shows that the presence of several positive emotions which we considered as Happy. However, the subject has some nagative valance but at the end the emotion continues to be happy which we conclude the emotion of this question is happy.

Figure 4.1.1.1 Emotion Detection according to VA (QS 1)

For question number 2 of Russell's model, the brain signals for this subject 1 shows mostly both of the valence is (+ve) and arousal (+ve) was positive that indicate her emotion for this question 2 is Happy.

Chart, line chart

Description automatically generated

Figure 4.1.1.2 Emotion Detection according to VA (QS 2)

Chart

Description automatically generatedQuestion 3’s brain signals of subject shows that positive emotion dominating subject’s brain signals even though the subject feel stress at the end.

Figure 4.1.1.3 Emotion Detection according to VA (QS 3)

Chart, histogram

Description automatically generatedThe brain signals for question 4 have tendency towards nagative emotion which indicate the subject feel stress while answering the question.

Figure 4.1.1.4 Emotion Detection according to VA (QS 4)

Chart

Description automatically generatedSubject brain signals of question 5 shows more positive valance instead of negative valance. According to her signals the subject has least indication of stress.

Figure 4.1.1.5 Emotion Detection according to VA (QS 5)

Chart, line chart

Description automatically generatedThe brain signals for question 6 is Happy in term of emotion. Only a bit nagative signals emerged. Her brain signals for this question are positive Valence (+ve) and positive Arousal (+ve).

Figure 4.1.1.6 Emotion Detection according to VA (QS 6)

Brain signals of subject in Question 7 of Russell's model also shows that positivity of emotion which produced absolute contradiction of his answer.

Chart

Description automatically generated

Figure 4.1.1.7 Emotion Detection according to VA (QS 7)

Chart, line chart

Description automatically generatedFor question 8, the subject has both positive and nagative emotion which is Fear and Happy. But positive emotion is more dominating that indicate the subject feel less stress while answering the question.

Figure 4.1.1.8 Emotion Detection according to VA (QS 8)

Chart, line chart

Description automatically generatedFrom question 9 for this student shows that the subject was Happy because her brain signals indicates that the subject had positive valence and positive arousal.

Figure 4.1.1.9 Emotion Detection according to VA (QS 9)

Chart

Description automatically generatedSubject brain signals of question 10 shows more positive valance instead of positive valance but it has also some nagative valence. So, we can conclude that this question has both Happy and Fear emotion.

Figure 4.1.1.10 Emotion Detection according to VA (QS 10)

Chart, line chart

Description automatically generatedQuestion 11 also being answered by subject with Happy emotion, but the brain signals also shows that the subject feel stress at the end.

Figure 4.1.1.11 Emotion Detection according to VA (QS 11)

Subject also shows Happy emotion in question 12 which indicate that his brain signals had positive valence and positive arousal.

Chart, line chart

Description automatically generated

Figure 4.1.1.12 Emotion Detection according to VA (QS 12)

Graphical user interface

Description automatically generated with low confidenceThese two graphs on Figure 13 and Figure 14 represent eyes closed before and after STEM questions being asked. Eyes closed is resting state of a subject to see how their brain activity while they are not doing any tasks. There are no significant changes can be seen as both graphs show same pattern in term of negative emotions.

Figure 4.1.1.13 Emotion Detection accoChart, line chart, histogram

Description automatically generatedrding to VA (EC Before)

Figure 4.1.1.14 Emotion Detection according to VA (EC After)

Chart

Description automatically generated with low confidenceBased on subject’s eyes opened before and after experiment, we can see obvious pattern that subject endured stress before experiment. We proposed that; subject might feel nervous before experiment is conducted.

Chart, line chart, histogram

Description automatically generatedFigure 4.1.1.15 Emotion Detection according to VA (EO Before)

Figure 4.1.1.16 Emotion Detection according to VA (EO After)

Subject 1 is low scorer student in math and science at school. Since the subject was having positive emotion Happy and Calm throughout the exam.

# STEM Subject 2

STEM subject 2 brain signals for the question 1 of Russell's model above shows that most valence was -ve and arousal +ve and negative (ups and down). However, according to this result, we could not find any specific obvious indication. For this Chart, histogram

Description automatically generatedquestion she is fear and sad emotion.

Figure 4.1.2.1 Emotion Detection according to VA (QS 1)

Chart, histogram

Description automatically generatedFor question number 2 of Russell's model, the brain signals for this subject 2 shows mostly both of the valence is (-ve) and arousal (-ve) was negative that indicate her emotion for this question 2 is sad.

Figure 4.1.2.2 Emotion Detection according to VA (QS 2)

Chart, line chart, histogram

Description automatically generatedQuestion 3 of Russell's model shows this question had Fear emotion due to her negative Valence (-ve) and positive Arousal (+ve) brain signal only indicate fair scale of stress.

Figure 4.1.2.3 Emotion Detection according to VA (QS 3)

The subject’s score in question 4 has similar brain signals as question 3. The brain signals show negative Valence (-ve) and positive Arousal (+ve) that clearly indicate that her emotion has fear for this question.

Chart, line chart

Description automatically generated

Figure 4.1.2.4 Emotion Detection according to VA (QS 4)

Chart, line chart

Description automatically generatedFor question 5, both of valence and arousal has positive and negative brain signals. There was negative valence (-ve) and positive arousal (+ve) brain signals, at the same time it has positive valence (+ve) and positive arousal (+ve) brain signals. According to his signals she has both fear and happy emotion.

Figure 4.1.2.5 Emotion Detection according to VA (QS 5)

Graphical user interface, chart, line chart

Description automatically generatedThe brain signals for question 6 is Sad in term of emotion. Only several positive signals emerged. Her brain signals for this question were negative Valence (-ve) and positive Arousal (-ve).

Figure 4.1.2.6 Emotion Detection according to VA (QS 6)

Question 7’s brain signals of subject shows calm, happy and fear emotion dominating subject’s brain signals. Mostly the signal shows positive valence and positive arousal.

Chart, line chart

Description automatically generated

Figure 4.1.2.7 Emotion Detection according to VA (QS 7)

Chart

Description automatically generatedQuestion 8 of for this subject has showed Sad and Calm emotion. The brain signals had both positive and nagative tendency.

Figure 4.1.2.8 Emotion Detection according to VA (QS 8)

Chart, line chart

Description automatically generatedSubject brain signals of question 9 shows more nagative arousal instead of positive arousal but it had also some positive valence. So, we can conclude that this question had Fear and Calm emotion.

Figure 4.1.2.9 Emotion Detection according to VA (QS 9)

Score from question 10 for this student shows that she was quite Fear because his brain signals indicates that she had nagative valence and positive arousal.

Chart, line chart, histogram

Description automatically generated

Figure 4.1.2.10 Emotion Detection according to VA (QS 10)

Chart

Description automatically generatedSubject also shows Fear in question 11 which indicate that her brain signals had nagative valence and positive arousal.

Figure 4.1.2.11 Emotion Detection according to VA (QS 11)

Chart

Description automatically generatedBrain signals of subject in Question 12 also shows that Fear emotion. But there were also some positive valence that means she had some calm emotion as well.

Figure 4.1.2.12 Emotion Detection according to VA (QS 12)

These two graphs on Figure 13 and Figure 14 represent eyes closed before and after questions being asked. Eyes closed is resting state of a subject to see how their brain activity while they are not doing any tasks. There are significant changes can be seen from both graphs. Before asking questions Eyes closed showed mostly Calm emotion but at the end after finishing asking question his emotion was Fear.

Chart, line chart

Description automatically generated

Chart

Description automatically generatedFigure 4.1.2.13 Emotion Detection according to VA (EC Before)

Figure 4.1.2.14 Emotion Detection according to VA (EC After)

Chart, histogram

Description automatically generatedHowever, for eyes opened graphs, there are similar pattern can be seen. The graph for eyes opened before questions being asked was showing that subject has Fear emotion and While the eyes opened for after questions being asked also shows Fear emotion, but there is bit of positive signal at the end. So we can conclude from your findings. This subject is in stress condition due to -ve precursor emotion ( fear ) and followed by -ve emotion (fear) while having STEM test. This could lead to stress condition.

Figure 4.1.2.15 Emotion Detection according to VA (EO Before)

Chart, line chart

Description automatically generated

Figure 4.1.2.16 Emotion Detection according to VA (EO After)

Since she is medium scorer in math and science at school. She might develop stress while having math and science test. It proof through physiological test when she is having -ve emotion ( fear ) during the test.

# STEM Subject 3

Score of subject’s first question of Russell's model shows that subject was fear because of his negative emotions and number of occurrences of nagative valance can be said that the subject was really suffered from stress as well in term of brain signal.

Graphical user interface, chart

Description automatically generated

Figure 4.1.3.1 Emotion Detection according to VA (QS 1)

Graphical user interface, chart, histogram

Description automatically generatedThe brain signals justify that the subject has only several occurrences of positive emotion which is Calm and Happy compared to nagative emotion that is fear and sad which indicates that the subject was stress.

Figure 4.1.3.2 Emotion Detection according to VA (QS 2)

Graphical user interface

Description automatically generatedSubject brain signal of question 3 shows more positive emotions instead of nagative. The signal shows that most of the time the subject emotion was Calm.

Figure 4.1.3.3 Emotion Detection according to VA (QS 3)

Graphical user interface

Description automatically generatedThe brain signal has tendency towards higher number of positive emotions which is an indication that the subject was not stress at that time. But at the end the subject shows negative emotion which is sad.

Figure 4.1.3.4 Emotion Detection according to VA (QS 4)

Graphical user interface, chart, histogram

Description automatically generatedAccording to score in question 5, subject scored maximum level of stress. The brain signal shows that the subject has higher number of negative emotions compared to positive’s.

Figure 4.1.3.5 Emotion Detection according to VA (QS 5)

In question 6 of Russell's model, subject’s emotions in his brain signal clearly showing a pattern of positive emotions rather than negative which we considered as not stressful.

Graphical user interface, application, Word

Description automatically generated

Figure 4.1.3.6 Emotion Detection according to VA (QS 6)

Chart

Description automatically generated with low confidenceBased on signal of a subject for question 7 from Russell's model, the subject has both positive and negative valance, the subject emotion was Calm, Fear and Sad.

Figure 4.1.3.7 Emotion Detection according to VA (QS 7)

Chart, histogram

Description automatically generatedBased on signal of subject for question 8 produced positive emotions from his brain signal indicates of Calmness. Most of the time the brain signal of this question was positive arousal and positive valance.

Figure 4.1.3.8 Emotion Detection according to VA (QS 8)

In question 9 of Russell's model, subject’s emotions in his brain signal also clearly showing pattern of positive emotions rather than negative which we considered as not stressful.

Graphical user interface

Description automatically generatedFigure 4.1.3.9 Emotion Detection according to VA (QS 9)

Chart

Description automatically generatedAccording to subject’s answer for question 10 of Russell's model the subject brain signal indicates mostly positive valance and arousal that indicate the subject emotion was Happy and Calm.

Figure 4.1.3.10 Emotion Detection according to VA (QS 10)

Graphical user interface

Description automatically generatedSubject shows Happy and Calm emotion in question 11 which indicate that his brain signals had mostly positive valence and positive arousal.

Figure 4.1.3.11 Emotion Detection according to VA (QS 11)

Graphical user interface

Description automatically generatedSubject for question 12 feel like the subject has high level of calmness which coincides with the brain signal recorded which determined as not stress.

Figure 4.1.3.12 Emotion Detection according to VA (QS 12)

Graphical user interface, application, histogram

Description automatically generatedWe can see the constancy of good emotions that occurred in both graphs by observing the subject's eyes closed before and after the experiment. Only a few unfavorable emotions can be seen with closed eyelids afterward, but there is no discernible difference. This means that the subject's emotional state is mostly the same before and after the experiment.

Figure 4.1.3.13 Emotion Detection according to VA (EC Before)

Chart

Description automatically generated

Figure 4.1.3.14 Emotion Detection according to VA (EC After)

Graphical user interface, chart, histogram

Description automatically generatedIn contrast, we can detect a clear pattern suggesting the subject was stressed prior to the experiment based on the subject's eyes opened before and after the experiment. We hypothesized that the individual might be apprehensive prior to the experiment. The subject, on the other hand, keeps the same emotion after the questions are answered.

Chart, histogram

Description automatically generatedFigure 4.1.3.15 Emotion Detection according to VA (EO Before)

Figure 4.1.3.16 Emotion Detection according to VA (EO After)

Overall analysis for brain signal of the subject is that this subject 3 is low scorer student in math and science at school. Since the subject is having a very high level of Happy and Calm during the exam.

# STEM Subject 4

Graphical user interface, application, Word

Description automatically generatedSubject 4 brain signals for the question 1 shows that the signal dominating positive emotions which we considered as Calm.

Figure 4.1.4.1 Emotion Detection according to VA (QS 1)

Brain signals for the question 1 for subject 4 shows that the presence of both several negative emotions and positive emotion which is Calm and Fear.

Chart

Description automatically generatedFigure 4.1.4.2 Emotion Detection according to VA (QS 2)

Graphical user interface, chart

Description automatically generatedQuestion 3 for this subject brain signals has both positive valence and negative arousal. The brain signals indicate that the subject has positive emotion which has no stress at all.

Figure 4.1.4.3Emotion Detection according to VA (QS 3)

Chart

Description automatically generatedThe brain signals for question 4 is very positive in term of emotion. Only several negative emotions emerged. This can be classified as severe stress, but his brain signals failed to indicate that.

Figure 4.1.4.4 Emotion Detection according to VA (QS 4)

Chart

Description automatically generated with low confidenceAccording to question 5 of Russell's model, the subject’s brain signals recorded shows that the subject was not under stress at all.

Figure 4.1.4.5 Emotion Detection according to VA (QS 5)

Graphical user interface, chart

Description automatically generatedQuestion 6 also shows that the subject’s brain signals is positive valance and nagative arousal. That specify the subject was not under stress at all.

Figure 4.1.4.6 Emotion Detection according to VA (QS 6)

Graphical user interface, application

Description automatically generatedAccording to question 7 of Russell's model, the subject’s brain signal started with a negative balance short period of time but it remains positive till the end which means the subject's emotion was calm.

Figure 4.1.4.7 Emotion Detection according to VA (QS 7)

The brain signal for question 8 also shows that the subject was not feeling stressed while answering the question.

Graphical user interface

Description automatically generatedFigure 4.1.4.8 Emotion Detection according to VA (QS 8)

Graphical user interface, application, Word

Description automatically generatedBrain signal recorded from subject for question 9 of Russell's model shows only positive emotions which, the subject is not in stress condition.

Figure 4.1.4.9 Emotion Detection according to VA (QS 9)

Graphical user interface, application, Word

Description automatically generatedThe signal for question 10 shows that the subject scored the highest score of positive emotion.

Figure 4.1.4.10 Emotion Detection according to VA (QS 10)

Graphical user interface, chart, histogram

Description automatically generatedBased on question 11 of Russell's model, the subject did not suffer any form of stress since the subject's brain signal is positive valence. However, a bit of stress can be seen in subject's brain signals.

Figure 4.1.4.11 Emotion Detection according to VA (QS 11)

Graphical user interface, chart

Description automatically generatedIn question 12, the subject suffered from mild stress which is for the brain signals recorded a high number of negative emotions which is considered a stressful condition.

Figure 4.1.4.12 Emotion Detection according to VA (QS 12)

Based on her brain signals for eyes closed before and after questions being asked to the subject, he has deteriorated in terms of the number of negative emotions. The number of positive emotions drops fully. His physiology and psychological state confirm that he was having a high level of stress.

Graphical user interface, chart

Description automatically generated with medium confidenceChart, line chart, histogram

Description automatically generatedFigure 4.1.4.13 Emotion Detection according to VA (EC Before)

Figure 4.1.4.14 Emotion Detection according to VA (EC After)

For the subject’s brain signals in the task of eyes opened before and after Russell's model being asked, there are no obvious changes or patterns compared to eyes close before and after. His brain signals show negative emotions.

Chart

Description automatically generatedGraphical user interface, chart

Description automatically generated with medium confidenceFigure 4.1.4.15 Emotion Detection according to VA (EO Before)

Figure 4.1.4.16 Emotion Detection according to VA (EO After)

We can conclude that the subject was not having stress according to his brain signals and he is a low scorer student in science and mathematics subjects.

# STEM Subject 5

Chart

Description automatically generatedHis score in question 1 of Russell's model shows that he was at mild level of stress because his brain signal shows that there were a number of negative emotions occurs but most of the time his emotion was positive.

Figure 4.1.5.1 Emotion Detection according to VA (QS 1)

Chart

Description automatically generatedBased on question 2 of Russell's model, he suffer less amount of stress since most of the time his brain signal was positive valence.

Figure 4.1.5.2 Emotion Detection according to VA (QS 2)

Chart, line chart, histogram

Description automatically generatedFor question 3 of Russell's model, he scored a recorded level of positive emotion according to his brain signals.

Figure 4.1.5.3 Emotion Detection according to VA (QS 3)

On the other hand, in his brain signals of question 4, negative emotions show a higher number of occurrences compared to positive which indicates that he was in stress condition. Most of the time his brain signal was negative valance and negative arousal.

Graphical user interface, chart, line chart

Description automatically generatedFigure 4.1.5.4 Emotion Detection according to VA (QS 4)

Chart, line chart, histogram

Description automatically generatedQuestion 5 of Russell's model for this subject brain signals has a tendency towards positive emotion which has the least indication of stress.

Figure 4.1.5.5 Emotion Detection according to VA (QS 5)

Chart, histogram

Description automatically generatedQuestion 6 for the subject indicates that he was not stressed due to his positive emotion. His brain signal shows positive valance more than negative valance which is considered as not stress.

Figure 4.1.5.6 Emotion Detection according to VA (QS 6)

Chart, histogram

Description automatically generatedThe brain signal of question 7 shows a similar signal as question 3. There was no negative emotion in his brain signal. That specify he was not stressed at all.

Figure 4.1.5.7 Emotion Detection according to VA (QS 7)

Brain signal for Russell's model in question 8 shows that subject recorded positive emotions more than negative emotions which is the subject is not stressful.

Chart, histogram

Description automatically generatedFigure 4.1.5.8 Emotion Detection according to VA (QS 8)

Similar emotion was also found for question 9, that subject was not stressed because positive emotion dominates his brain signal.

Chart, histogram

Description automatically generatedFigure 4.1.5.9 Emotion Detection according to VA (QS 9)

Chart, histogram

Description automatically generatedRussell's model for question 10 shows a remarkable brain signal. He had no negative emotion for this question.

Figure 4.1.5.10 Emotion Detection according to VA (QS 10)

Chart, histogram

Description automatically generatedAccording to question 11 of the subject’s brain signal recorded shows that he was not under stress all the time but for a particular time the brain signal shows negative emotion which is classified as mild stress.

Figure 4.1.5.11 Emotion Detection according to VA (QS 11)

Graphical user interface, chart, line chart, histogram

Description automatically generatedQuestion 12 of Russell's model for brain signal signifies that subject was not enduring stress as he had positive emotion.

Figure 4.1.5.12 Emotion Detection according to VA (QS 12)

Chart

Description automatically generatedFrom observation made on the subject’s eyes closed before and after the experiment, we can see the consistency of negative emotions that occurred in both graphs. There was no positive emotion is spotted. This means that patient has a similar state of emotion before and after the experiment is conducted.

Chart, histogram

Description automatically generatedFigure 4.1.5.13 Emotion Detection according to VA (EC Before)

Figure 4.1.5.14 Emotion Detection according to VA (EC After)

Diagram

Description automatically generatedOn the other hand, subject’s eyes opened before and after the experiment, we can see an obvious pattern that the subject endured stress before the experiment. We hypothesized that the individual could be apprehensive before the experiment. Our hypothesis can be proved by observing his brain signal after the experiment is conducted, he has mostly positive emotion after questions being asked.

Figure 4.1.5.15 Emotion Detection according to VA (QS EO Before)

Chart, histogram

Description automatically generatedFigure 4.1.5.16 Emotion Detection according to VA (EO After)

Overall, the subject can be said as roughly stressed due to the fact that there were some negative emotions in his brain signals. Because of this subject is a medium scorer in science and math subject in his school.

# STEM Subject 6

The score of the subject’s first question 1 of Russell's model shows that his negative emotions’ number of occurrences can be said that he was really suffered from stress in terms of brain signals.

Chart, line chart, histogram

Description automatically generatedFigure 4.1.6.1 Emotion Detection according to VA (QS 1)

Graphical user interface, chart, line chart

Description automatically generatedFor question 2 the subject's brain signals justify that he has only several occurrences of positive emotion compared to negative emotion which indicates that he was stressed.

Figure 4.1.6.2 Emotion Detection according to VA (QS 2)

Chart

Description automatically generatedThe subject’s brain signals for question 3 shows that he was having more positive emotions instead of negative emotion. Mostly he was happy and calm, but he had some negative feelings like sadness and fear while answering the question.

Figure 4.1.6.3 Emotion Detection according to VA (QS 3)

Chart

Description automatically generatedThe brain signal of the subject in Question 4 of Russell's model also shows the positivity of emotions.

Figure 4.1.6.4 Emotion Detection according to VA (QS 4)

Chart, histogram

Description automatically generatedAccording to question 5 of Russell's model, the subject had minimum level of relaxation. His brain signal shows that he has higher number of negative emotions compared to positive’s.

Figure 4.1.6.5 Emotion Detection according to VA (QS 5)

Chart, histogram

Description automatically generatedQuestion 6 of his brains signifies that he has only several occurrences of negative valance compared to positive valance which indicates that he was less stressed at that time. Mostly the subject was happy and Calm.

Figure 4.1.6.6 Emotion Detection according to VA (QS 6)

Chart, line chart

Description automatically generatedThe brain signal for this subject for question 7 has tendency towards negative emotions which is an indication that he was stress at that time.

Figure 4.1.6.7 Emotion Detection according to VA (QS 7)

Chart, line chart

Description automatically generatedThe brain signal of the subject in Question 8 of Russell's model also shows the negativity of emotions which are fear and sadness.

Figure 4.1.6.8 Emotion Detection according to VA (QS 8)

Graphical user interface, chart, line chart, histogram

Description automatically generatedAccording to the score in question 9, the subject's brain signal shows that he has the highest number of negative emotions.

Figure 4.1.6.9 Emotion Detection according to VA (QS 9)

Chart, line chart

Description automatically generatedFor question 10 of the subject, his brain signal signifies that he has only several occurrences of positive emotions compared to negative emotions which indicate that he was stress at that time.

Figure 4.1.6.10 Emotion Detection according to VA (QS 10)

Chart, line chart

Description automatically generatedThe subject’s emotions in his brain signal also clearly show a pattern of negative emotions rather than positive which we considered as stressful.

Figure 4.1.6.11 Emotion Detection according to VA (QS 11)

Chart, line chart, histogram

Description automatically generatedFor question 12 of Russell's model that signifies mild stress endured by the subject, his brain signal shows a higher number of negative emotions along with less number of positive emotion 'happy'.

Figure 4.1.6.12 Emotion Detection according to VA (QS 12)

Graphical user interface, chart

Description automatically generatedFor the eyes closed task before and after the experiment, there is similar pattern can be found. Both graphs show the subject was in stressful state at that time. There is some positive emotion that can be found in eyes close after.

Chart, line chart, histogram

Description automatically generatedFigure 4.1.6.13 Emotion Detection according to VA (EC Before)

Figure 4.1.6.14 Emotion Detection according to VA (EC After)

Chart, line chart

Description automatically generatedFor both eyes opened before and after experiment indicates similar scenario. Stress patterns can be spotted both on eyes opened after and before the experiment graph.

Chart

Description automatically generatedFigure 4.1.6.15 Emotion Detection according to VA (EO Before)

Figure 4.1.6.16 Emotion Detection according to VA (EO After)

Overall analysis for brain signal of the subject is that this subject is having a severe level of stress since there are more than 90% of his brain signals show critical number of negative emotions and this subject is a good scorer in math and science subject in his school.

# STEM Subject 7

Chart, histogram

Description automatically generatedSTEM subject 7 brain signals for question 1 of Russell's model below shows that there is presence of several negative and positive emotions which are sad and happy.

Figure 4.1.7.1 Emotion Detection according to VA (QS 1)

For question number 2 of Russell's model, the brain signals for subject 7 shows similarities in emotion like question 1. Most of the emotions are happy but there is also some negative emotion that can be identified.

Chart, histogram

Description automatically generatedFigure 4.1.7.2 Emotion Detection according to VA (QS 2)

Chart, histogram

Description automatically generatedThe brain signals show more positive emotions compared to negative emotions. That indicates the subject had some presence of stress while answering the question.

Figure 4.1.7.3 Emotion Detection according to VA (QS 3)

Graphical user interface, chart, line chart

Description automatically generatedThe brain signals for question 4 is very positive in term of emotion. Only several negative emotions emerged.

Figure 4.1.7.4 Emotion Detection according to VA (QS 4)

Chart, line chart

Description automatically generatedQuestion 5’s brain signals of the subject show that positive emotions dominating the subject’s brain signals even though in the beginning his emotion was negative.

Figure 4.1.7.5 Emotion Detection according to VA (QS 5)

Chart, line chart

Description automatically generatedQuestion 6 of Russell's model for this subject the brain signals have tendency towards negative emotion which has the least indication of comfort.

Figure 4.1.7.6 Emotion Detection according to VA (QS 6)

Chart

Description automatically generated with low confidenceSubject brain signals of question 7 shows more positive valance instead of negative valance. That signifies the subject was happy while answering the question but there was some negative emotion sad found.

Figure 4.1.7.7 Emotion Detection according to VA (QS 7)

Chart, histogram

Description automatically generatedQuestion 8 of Russell's model for this subject shows that he was not quite stressful. In his brain signals indicate that the number of positive emotions dominates over negative emotions

Figure 4.1.7.8 Emotion Detection according to VA (QS 8)

Chart, histogram

Description automatically generatedBased on this subject question 9, his brain signals gives an insight that he is not having positive emotion enough to be considered as not stress.

Figure 4.1.7.9 Emotion Detection according to VA (QS 9)

Graphical user interface, chart, histogram

Description automatically generatedThe subject in question 10 of Russell's model indicates that he was in mild stressful state. His brain signals which shows that he was having more tendency towards positive emotions.

Figure 4.1.7.10 Emotion Detection according to VA (QS 10)

Chart, line chart

Description automatically generatedHis brain signal shows negative emotions more than positive emotions which can be concluded that the subject is in minimal stress condition.

Figure 4.1.7.11 Emotion Detection according to VA (QS 11)

Chart, line chart

Description automatically generatedAccording to question 12, the subject’s brain signal recorded shows that he was not under stress because most of the time his brain signal was positive valance for this question which is classified as mild stress.

Figure 4.1.7.12 Emotion Detection according to VA (QS 12)

Based on the subject’s eyes closed before and after the experiment, we can see an obvious pattern that the subject endured stress before the experiment. Observing his brain signal after the experiment is conducted, he was not stressed all the time there was some positive emotion that can be found after the question was asked.

Graphical user interface, chart, line chart

Description automatically generatedGraphical user interface, chart

Description automatically generatedFigure 4.1.7.13 Emotion Detection according to VA (EC Before)

Figure 4.1.7.14 Emotion Detection according to VA (EC After)

However, mixed emotion can be found on eyes opened before and after the experiment. Both signals show negative emotions and positive emotions in regard to stress which is happy and sad.

Chart, histogram

Description automatically generatedGraphical user interface, chart

Description automatically generatedFigure 4.1.7.15 Emotion Detection according to VA (EO Before)

Figure 4.1.7.16 Emotion Detection according to VA (EO After)

Since he is a high scorer in math and science at school. Overall analysis on subject brain signals shows that subject has a mixture of results in terms of stress. Some of the brain signals show consistency with answers in questions of Russell's model while some are not.

**CHAPTER FIVE**

**CONCLUSION AND FUTURE WORK**

**5.1 Conclusion**

As the conclusion, the lowest grade (F) students are having (+ve) valence and arousal which shows happy emotion. This indicates that low scorer student might having less stress condition because they do not bother about the result at all. While intermediate scorer subjects are having both positive and negative valence which shows fear emotion. This shows how stressful they are when dealing with STEM exam or test. Finally for high scorer subjects, they are having negative valence for hard questions which indicate that High grade students having stress due to high expectation to score high in exam but still manage to answer the questions correctly. Thus, this kind of profiling is important to help the student to improve their emotion and stress level. In addition, teachers and parents can also identify their student who is having difficulties in dealing with their emotion and stress level, so they can pay more attention to the students.

**5.2 Future Work**

Based on assessment we'd like to suggest some improvements for future study based on the progress we've achieved and the problems we've encountered. We recommend that the dataset from the EEG machine being feature extracted and the data be analyses using another appropriate technique. For instance, the usage of Kernel density estimation, ANFIS and Support Vector Machine (SVM) should be included to the machine learning algorithm for feature extraction and analysis. To get the best possible results, we could compare and cross-validate the accuracy of data testing between different sorts of feature extraction and two types of machine learning algorithms.

Moreover, we’ll also be looking towards analyzing more data, since more data will lead to a more accurate and consistent outcome. Finally, we'll compare stress levels and early detection of anxiety among STEM students.

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**APPENDICES**

**Timeline

Description automatically generatedAppendix A**

Timeline

Description automatically generated

Graphical user interface, application, Word

Description automatically generated**Appendix B**

Graphical user interface, text, application, email

Description automatically generated