IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁜ Impact Factor 8.066 ⁜ Peer-reviewed / Refereed journal ⁜ Vol. 10, Issue 5, May 2023

DOI: 10.17148/IARJSET.2023.10572

Performance Analysis of Learning Capabilities Of Students In Ambient Atmosphere Using Bci

Dr. Gururaj K S[1], Ananya M D[2], Nagashree P[3], Nireekshitha R[4], Ruchitha S[5]

Professor and Head,Dept. of Information Science & Engineering,Gsss Institute Of Engineering & Technology For Women[1]

Students, BE Dept. of Information Science & Engineering,Gsss Institute Of Engineering & Technology For Women[2-5]

Abstract: A technique for measuring the learning capabilities of the student based on normal brain signals is examined and evaluated. There exists a variety of sensors that monitor brain activity and also provide the basis for a BCI. It also includes electroencephalography (EEG). Multiple sensors that exist can in principle detect relevant signals. Practicality and speed considerations exclude most of these options so almost all BCI systems to date depend on detecting signals using sensors. The impact of different environmental conditions has different effects on Cognitive Function. Brain-Computer Interface (BCI) technology for measuring and evaluating a student's learning ability in a variety of settings. Presumably, the paper discusses how BCI technology can track brain activity, such as attention and cognitive task, as the student learns in different environments. The purpose of this research is obviously to determine which environmental factors, such as noise or lighting, have an effect on the learner's ability to learn and retain information.

Keywords: Brain-Computer Interfacing (BCI), Electroencephalography (EEG), Cognitive Function, Sensors.

I. INTRODUCTION

Evaluating a student's learning ability in the context of his or her environment is key to understanding an individual's learning potential. With the advent of technology, analyzing and tracking student performance in real-time has become possible. Through this evaluation, it is feasible to distinguish solid areas and shortcomings, which can be utilized to customize learning and work with learning results. Functional assessment of learning ability in environmental climates requires assessment of various factors that affect learning outcomes, such as attention, active participation, and information retention. It involves the use of both objective and subjective measures to assess the effectiveness of the learning environment and the learner's response to it. Overall, assessing learning ability in an environmental context can provide valuable insights for teachers, parents, and students themselves. It can reveal specific intervention areas.

II. PROPOSED SYSTEM

The proposed system is research-based. In The initial step, the signals of the students are collected under various environmental conditions. The data is analyzed using graph plots to produce certain patterns to obtain the result of the study of the learning capabilities of a student in various environments.

III. LITERATURE SURVEY

[1] This paper focused on converging the evidence from various studies suggesting that the learning capabilities of elementary and high school students enhanced in contact with nature. This study examined the relationship between greenness and academic achievement among 450 public schools in Washington State. This study used two different measures of greenness, at two different scales and also with two different measures of achievement at school, this is the percentage of students exceeding state standards in reading and math. Six among eight spatial error models showed a significant positive relationship between the achievement of students and greenness around the school. If a community wants to experiment by greening schools for academic achievement, then this study provides clues as to where and what type of plant is to be planted, and also it suggests that planting trees within 250m will maximize the effect on achievement.

[2] This paper describes childhood socioeconomic status (SES) is a socioeconomic state that a child undergoes in their early life, such as their education, family's income, neighborhood environment, and occupation. Childhood SES is found to be the strongest predictor of lifelong well-being. This study reviews the evidence that experiences that are related to childhood SES affect not only the result but also brain development. This study hypothesizes that the greater the exposure to stress the greater the acceleration of brain maturation, whereas the greater the access to positive experiences

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the greater the deceleration of maturation. This study provides a unique framework for research on environmental influences on brain development.

[3] This study has done prior research that has shown a positive effect of indoor nature that as potted plants and green walls on the health, attention, and well-being of different groups, including students. The main objective of this study was to examine if these effects also emerge when students participate in a single lecture in a classroom surrounded by indoor nature. Three different longitudinal field experiments were conducted at a university(N=70), a secondary vocational school (N=161), and a secondary school (N=213), examined the attention, health complaints, well-being, accomplished environmental quality with tests and questionnaires with respect to attention, and lecture evaluation. The students reported greater lecture evaluation and attention after one lecture in the classrooms having indoor nature when compared to the classrooms without indoor nature. No intervention effects were found on students.

[4] In this study, a systematic review is done on the evidence of the effects of nature in the study environment on academic outcomes, well-being, and the outcomes that are related to explanatory pathways among secondary and tertiary education students. The protocol preferred and preregistered was at Prospero (CRD42019126718). A statistical search was made using two databases that yielded 3410 articles, out of which 37 studies were chosen for the review. Many studies had a high risk of biasing and had heterogeneous results and exposure measures. Therefore, no proper conclusions could be drawn. Although, promising votes were found on the alliance between improved quality of life, lower outdoor temperature, perceived restoration, and campus green space, and between improved indoor climate and indoor nature.

[5] This study says that in this era, most students face stress, which is one of the most common problems. Serious health problems such as depression, anxiety, heart disease, and sleep disorder are because of long-term stress. This study has proposed the most efficient stress level detection framework for detecting stress among students using Electroencephalogram (EEG) signals. This EEG classifies stress at three different levels; high stress, medium stress, and low stress. According to the experiment, the EEG data is collected by the placement of two electrodes in the prefrontal region from six subjects. The EEG data is collected each time the subject solves arithmetic questions under heavy pressure. A Band-pass filter is used to pre-process the collected data by removing artifacts and proper features are extracted through the PyEEG module and wavelet packet transform. The best features are selected using the ReliefF feature selection method. And later Gaussian classification is used to categorize the selected feature set into three categories. An accuracy of 94% is predicted to classify the level of stress according to the proposed framework.

[6] The main objective of this paper is to explore a fundamental change in Brain-Computer Interface (BCI) research, and also on best practices for the rehabilitation and training of students with disorders of neurodevelopment. In the present line of work, it indicates that the use of BCI devices has a positive effect on students; working memory and attention skills as well as on different skills likely, social, visuospatial, emotional abilities, and imaginative. The aim of BCI applications is to address the understanding of each of the students and to emulate human brains. Applications based on BCI can potentially regulate the cognitive abilities of students when used for their rehabilitation and training. This study examines the enhancement of BCI research till now.

[7] This paper describes Brain-Computer Interfaces (BCIs) as a novel technology that has emerged and it connects external devices with the brain. The development of BCI is to decode the intentions of humans that lead to direct control of the device's or computer's brain activities without undergoing the neuromuscular pathway. Brain control is not only allowed by the Bidirectional brain-computer interfaces, it also opens a way for modulating the nervous system via neural interfacing. This study reviews the principles, concepts, and different foundation blocks of BCIs. The different foundation blocks are signal acquisition, signal processing, feature extraction, and feature translation, to various applications and, device control. This paper also discusses the challenges and performance of BCIs.

[8] According to this study, policymakers and scholars have condemned public education for never-ending income and health disparities in developed countries. The ties between academic performance and green space, brainstorming that green space is able to enhance performance, and also, in further time reduce disparities have been examined by several studies. In this study was done having 13 peer-reviewed articles which examine the relationship between types of green spaces, academic outcomes, and distances where measurement of green spaces was done around the schools. The outcome was among 122 finding in 13 articles, 64% non-significant, 8% negative and significant, and 28% positive and significant. Greenness, green land of distances up to 2000m in the surrounding of schools, and tree cover is referred to as positive findings. By semester end college preparatory exams and semester grades manifested huge shares of positive relations than reading or math test scores.

[9] This study shows the influence of indoor physical environments on learning efficiency these days. In order to improve learning efficiency, scenarios of the environment have to be planned and designed when the occupants engage

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themselves in various learning tasks. The main objective of the current study is to traverse the effects of three factors of the physical environment likely, temperature, illumination, and noise on learning efficiency based on various types of tasks, including memory, perception, attention-oriented tasks, and problem-solving. An experiment of 3x4x3 full factorial design was done in a classroom of 10 subjects at a university. Based on different temperature levels, , illuminance, and noise, environmental scenarios were generated. Learning efficiency was quantified using accuracy rate, final performance indicator, and reaction time. The outcome that could be observed was, ambient noise, temperature, and illuminance employed significant effects on learning efficiency depending on four types of tasks. The finest environmental scenarios for learning efficiency were later recognized under various environmental interactions.

[10] This study focuses on understanding cognitive flexibility, efficiency, cognitive load, and learning implications. Cognitive load theory is a psychological theory that expresses the amount of mental effort that is used by working memory at a certain given time. Many recent pieces of research have manifested that Electroencephalogram (EEG) can be a dependable tool to compute the cognitive load one may experience while executing different tasks. There is a two-phase study that is recognized by this knowledge, the main aim of which is to innovate a mapping for cognitive load in the design process of engineering, this provides a way to distinguish between advanced engineering students and novice engineering students. In the first phase, the ability to compute cognitive load in brainstorming situations can be evaluated in the B-Alert EEG system. The senior engineering and sophomore students were connected to the B-Alert system and were asked to solve engineering-related problems with varying complexity. Based on the collected data, the relationship. Further analysis of the data was done. In the second phase cognitive actions of both the advanced and novice engineering students were analyzed.

[11] In this paper the learning outcome of the students is dramatically affected by the learning environment. Noise, insufficient light, schools' open space, inappropriate temperature, overcrowded classes, inappropriate classroom layout, and misplaced boards are the factors that can be distracting students in class. This study was to inspect how environmental factors impact elementary students' academic achievement and learning. The database is from Magiran, SID, Google Scholar, etc. Initially, 252 articles were highlighted by searching the databases out of which 39 articles were chosen based on pieces of advice from medical education experts. Quality evaluation and analysis of data extraction were performed by investigators. The outcome showed that noise around educational institutions has appropriate and negative coloring. The main shoutout from this study to educational managers is to take into account the environmental factors while designing educational environments.

IV. COMPARISON TABLE

AUTHORS	YEAR	METHODOLOGY	LIMITATIONS
Ming Kuoa, Samantha E Kleina, Matthew HEM Browning, JaimeZaplatoschc	2021	This study used two different measures of greenness, at two different scales and also with two different measures of achievement at school, this is the percentage of students exceeding state standards in reading and math	If the observed greenness-achievement relationship is causal, what might be planted to boost achievement most effectively
Ursul Tooley, Danielle S. Bassett	2021	The emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) as a global public health crisis.	The great threat to the animal healthas well as to human those are in direct contact with animals

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Karin Tanja-Dijkstra b, Jolanda Maas c, Michiel R. de Boer	2020	The main objective of this study was to examine if these effects also emerge when students participate in a single lecture in a classroom surrounded by indoor nature,	Attending only one lecture in a classroom with indoor nature does not seem to provide immediate effects on health and well-being
Nicole van den, Bogerd a, S. Coosje Dijkstra, Sander L. Koole b, Jacob C. Seidell a, Ralph de Vries c, Jolanda Maas b	2020	In this study, a systematic review is done on the evidence of the effects of nature in the study environment on academic outcomes, well-being, and the outcomes that are related to explanatory pathways	Most studies had a high risk of bias and there were heterogeneous outcome and exposure measures. Hence, no firm conclusions could be drawn
Mayo clinic	2020	This study has proposed the most efficient stress level detection framework for detecting stress among students using Electroencephalogram (EEG) signals.	Poor spatial resolutions. Most sensitive to a particular set of post-synaptic potentials.
Sarah N. Abdulkader *, Ayman Atia, Mostafa-Sami M. Mostafa	2020	BCI system records the brain waves and sends them to the computer system to complete the intended task	They express the limitations facing the user acceptance of BCI technology utilization. They include the issues related to the training process necessary for classes' discrimination
Matthew H. E. M. Browning * and Alessandro Rigolon	2019	This protocol describes four steps in the selection of empirical articles: identification; screening, which involves reading titles and abstracts	The extant body of literature examining school green space and academic performances small, shows mixed results
Lee Taylor,Samuel L. Watkins, Hannah Marshall	2018	Cognitive function defines performance in objective tasks that require conscious mental effort.	Usability Challenges: They express the limitations facing the user acceptance of BCI technology utilization
Blaize Majdic, Charles Cowan, Justyn Girdner, Winifred Opoku, Olga Pierrakos, Elise Barrella	2017	The device interacts with a data analysis software package from Advanced Brain Monitoring (ABM) called B-Alert Live.	This wide range of cognitive stimulation comes from the fact that there are a multitude of problem types

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Abdolreza Gilavand	2016	This study was to inspect how environmental factors impact elementary students' academic achievement and learning. The database is from Magiran, SID, Google Scholar, etc.	Facing the user acceptance of BCI technology utilization is the limitation. They include the issues related to the training process necessary for class discrimination.

V. METHODOLOGY

Brain-Computer interface innovation addresses a profoundly developing field of exploration with application frameworks. A BCI framework identifiesthe presence of explicit examples in a person's continuous mind movement that connects with the person's intention to initiate control. The BCI framework translates these examples into significant control orders. BCI has highlighted extraction, including determination/dimensionality decrease, highlight characterization, and post-handling blocks.

The presentation examination of learning capacitiesof understudies in a surrounding air utilizing Cerebrum PC Connection point (BCI) is a task that means exploring how BCI innovation can be utilizedto gauge the mental exhibition of understudies invarious ecological circumstances. The undertakingincludes recording EEG signals from the cerebrums of understudies as they take part in various learning errands and dissecting the signs to distinguish examples of mind movement related to variousdegrees of mental execution.

A. Selecting the participants

The initial step is to choose a gathering of members who will take part in the review. Members ought to be illustrative of the number of inhabitants in interest,for example, understudies of a specific age range or instructive level.

B. Setting up the BCI system

The subsequent stage is to set up the BCI framework that will be utilized to record EEG signals from the members. This includes choosing a fitting EEG headset, arranging the product to record EEG information, and it is appropriately adjusted and approved to guarantee that the framework.

Fig 1: EEG headband

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C. Conducting the studyThe review includes having members play out aprogression of learning errands in various ecologicalcircumstances, like in a tranquil homeroom, an uproarious cafeteria, or a faintly lit library. The errands might incorporate understanding cognizance,numerical statements, or memory review undertakings. EEG signals are recorded during the undertakings, and the exhibition of the members is estimated utilizing standard measurements, for example, precision or reaction time.

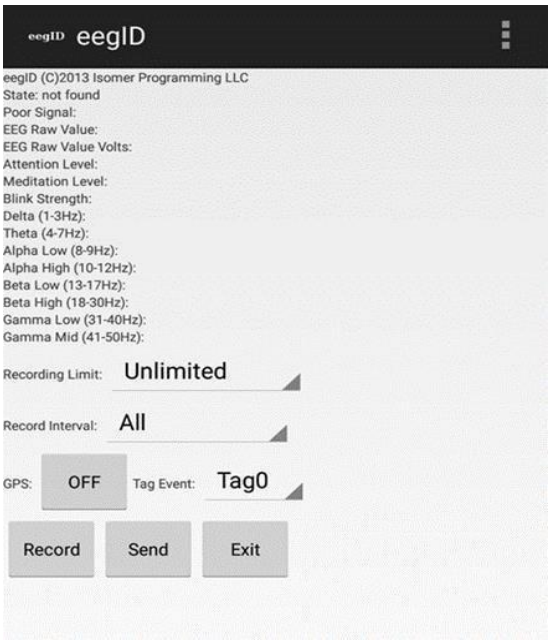

Fig 2: EEG ID Reader

D. Analyzing the data

The EEG signals recorded during the review are broken down utilizing signal handling and AI methodsto recognize examples of mind movement related to various degrees of mental execution. This mightinclude utilizing strategies, for example, unearthly examination, occasion-related potential (ERP) investigation, or example acknowledgment calculations.

E. Interpreting the results

The last step is to decipher the consequences of the examination and make inferences about what different natural circumstances mean for mental execution. The discoveries of the review can educate the advancement regarding mediations to further develop learning results in various conditions, for example, by upgrading homeroom plans or utilizing versatile learning advancements.

VI. RESULTS AND DISCUSSION

As our project is related to analyzing the learning capabilities of students in variant atmospheres, here we are analyzing users' learning capabilities in four different conditions environment condition, class condition, canteen condition, and lab condition. In this section data analysis using Python will be discussed Here let us analyze why we make use of Python for the data analysis will be discussed. Moreover, how anyone can start using Python will be shown. The important libraries, platforms, and datasets to perform analysis will be introduced. Usage of various Python functions for data analysis are provided here along with various formats for plotting graphs or charts are discussed.

Histogram: A histogram is a data representation that seems to be a bar graph that provides a variety of outcomes into columns along the x-axis. The y-axis can be utilized to present data distributions by representing the numerical count or percentage of occurrences in each column. Histogram in python can be drawn using matplotlibpyplot.hist()-

```
plt.hist(subdata,bins=7)
plt.xlabel("various parameters")
plt.ylabel("counts")
```

Stem Plot: A stem plot gives vertical lines from the baseline to the y axis and fixes a marker at each x point. The x-

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positions are not necessary. The formats can be specified as keyword-arguments or as positional arguments. Stem plot in python can be drawn using matplotlib.pyplot.stem()
plt.stem(mydata[‘attention’])

Box Plot: This box plot is the representation and comparison of groups of data. The box plot depicts the level, spread, and symmetry of data distribution by using the median, approximate outliers and the lowest data and the highest data points (extreme values).
sns.boxplot(x=”attention”,y=”meditation”,data=h
eaddata,palette=”coolwarm”)

Scatter plot: At scatter plot dots will be used to indicate values for two different numeric variables The values for each of the data points are indicated by the position of their respective dots on the horizontal and vertical axes. These scatter plots are used to see how variables relate to one another.
Plt.scatter(x=”attention”,y=”meditation”,data=su
bdata,marker=”*”,color=”green”)

Class Condition

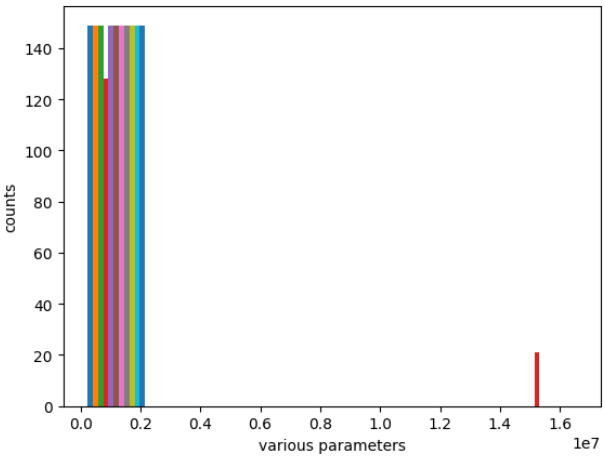

Fig 3: Histogram of the class condition of the student

We can observe from the above graph that, it is being plotted for all the eleven parameters as per the data collected. We can observe that the student has maximum concentration from the second and third lines respectively. But as moved further we can see that the fourth line is having a low reading because it is indicating the delta frequency which is associated with deep sleep, relaxation, and unconsciousness. Since the student has a high attention value, it implies a low delta value. The following two lines indicate alpha low which is associated with relaxed wakefulness and can be seen during activities such as meditation or relaxation, then followed by alpha high which is associated with relaxed wakefulness but may be more related to focused attention or mental effort hence are having high values respectively. Since at first, the user has got high values for attention meditation it implies the above. In the same way, we have Beta low which is associated with active thinking, concentration, and problem-solving followed by Beta high which is associated with active thinking and may be more related to working memory or cognitive control values are also higher. Moving further we have the gamma frequency value to be high, which indicates the student is attentive in the class and is not in the drowsy mood.

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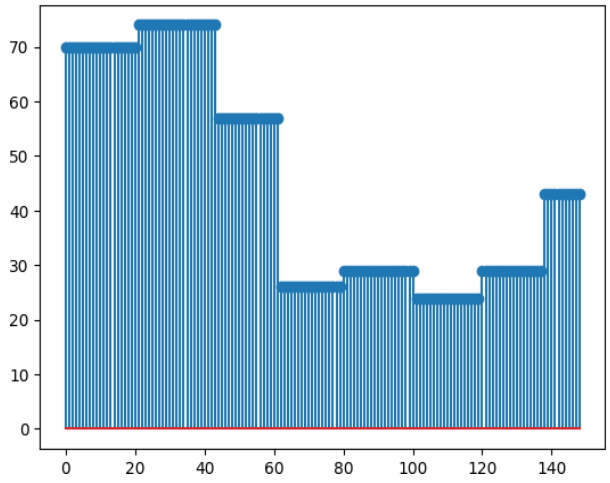

Fig 4: **S**tem plot class condition of the student

Here this graph depicts the stem plot for the student in class condition wherein the student's attention and meditation values are changing frequently as shown in the graph in x axis for the dataset from zero to one fifty. We can observe from the above that there are many intervals showing attention levels which means that the student is nevertheless having concentration but it is frequently changing hence is as depicted in the above graph.

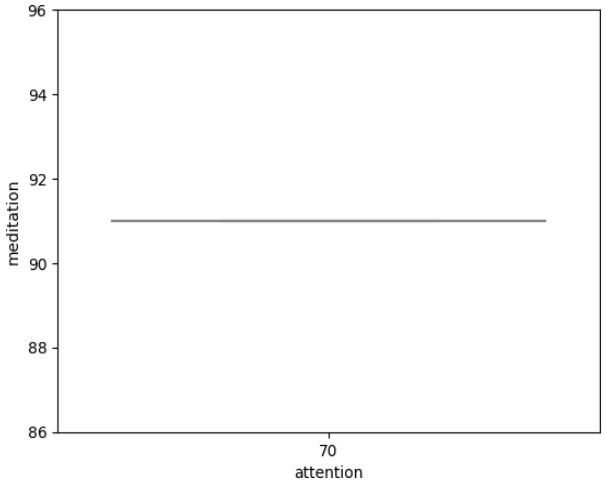

Fig 5: Box plot class condition of student

This graph depicts the box plot for student 1 which shows that the student is having attention level of 89 at the same time also has a meditation level of sixty-three which means there is normal coordination between attention and meditation where the student is having considerable amount of both attention and meditation levels as described in the above graph.

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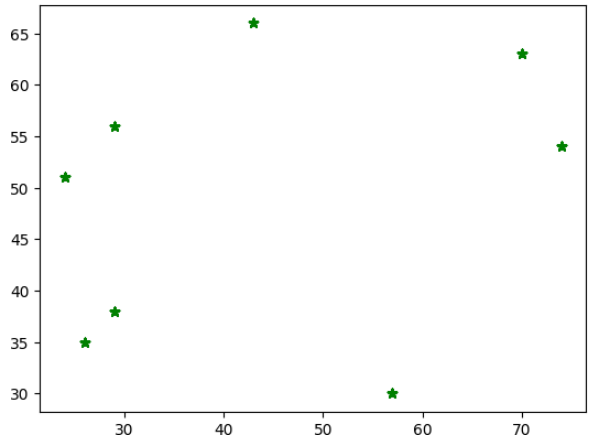

Fig 6: Scatter plot class condition of the student

The above Scatter plot is taken for "Attention" and "Meditation" values for student 1 in the class condition. In the graph, x-axis is taken for attention and the y-axis is taken for meditation and for marker i.e., for identification we have used an asterisk i.e., the star symbol and colour as green, the marker and color can be taken of any of our choices. From the graph we can observe that the number of stars obtained are equal to the different values of the data which has obtained in the class condition from Student 1. As we know that student has more attention and meditation in the class condition than in the noise condition. Hence a greater number of stars means more different values i.e., less Attention and Meditation and a smaller number of stars is obtained when less different values i.e., for more Attention and Meditation. Hence, we can say that Student 1 has more Attention and Meditation in the Environment condition than in the Noise condition.

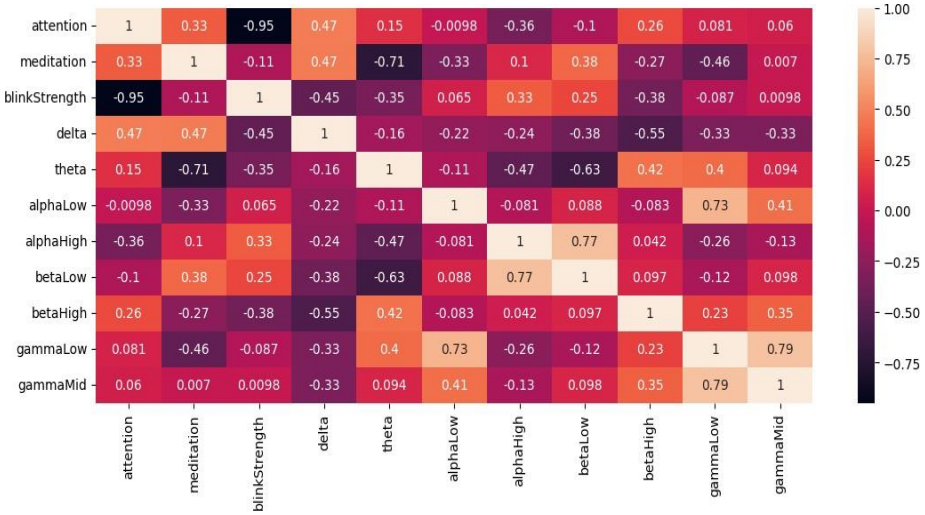

Fig 7: Heat map class condition of the student

The heat map shows the correlation with not just two parameters but through all the parameters. Firstly, moving on to the heat map in a Class condition where Attention through attention correlates to value as one, following with attention with blink strength is low hence we have a negative value depicted through dark color. As we move further we can see that the correlation between various attributes has been increasing showing student's high concentration and correlation between various parameters. Hence the color coding is shown to be the light color representing the correlation between the parameters.

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Environment condition

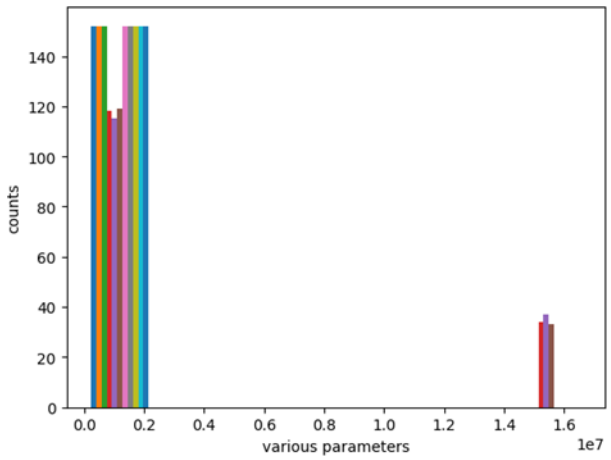

Fig 8: Histogram for the environmental condition of student

In environmental condition, histogram we can observe that student attention meditation blink strength are high whereas the alpha lo associated with unconscious, sleepiness are low. In addition to it we have beta high and beta low values to be high which means the student is in the active mode having creative thinking and cognitive ability as shown by other lines in the graph depicting the theta gamma values but the student is not in drowsiness condition. Hence we conclude that the student has a considerable amount of attention, meditation, and other associated parameters.

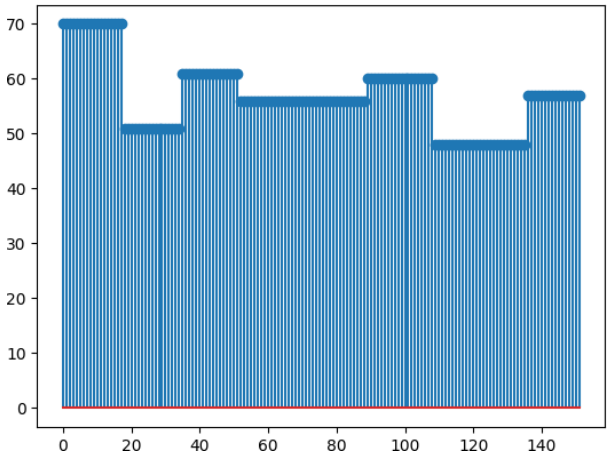

Fig 9: Stem plot environment condition of the student

Here this graph depicts the stem plot for the student attention level in the environment condition. As we can observe from the above graph that the student is having high concentration in this environment condition and most of the data values have constant attention values which mean its frequency band is almost constant for attention, which is depicted through the x-axis data values corresponding to y-axis.

The below graph shows the box plot for the environmental condition with the x-axis as attention and y axis as meditation. Here the graph is almost like above graph but here we have a considerable amount of change is that here even though we have an attention level to be seventy but at the same time we also have a meditation level to be ninety-one which means there is a significant amount of coordination among these two different attributes namely the attention and meditation. Hence the values is shown as in the above graph.

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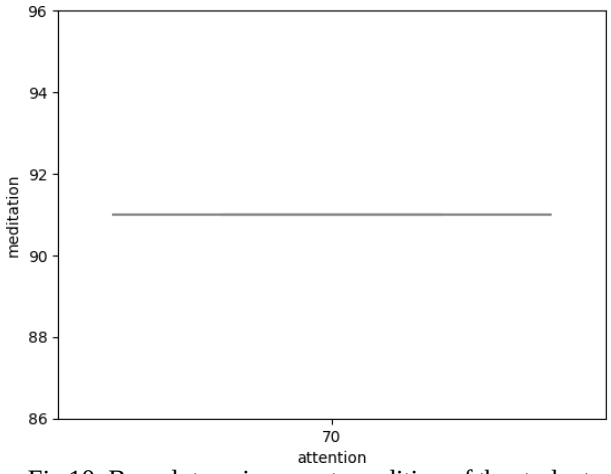

Fig 10: Box plot environment condition of the student

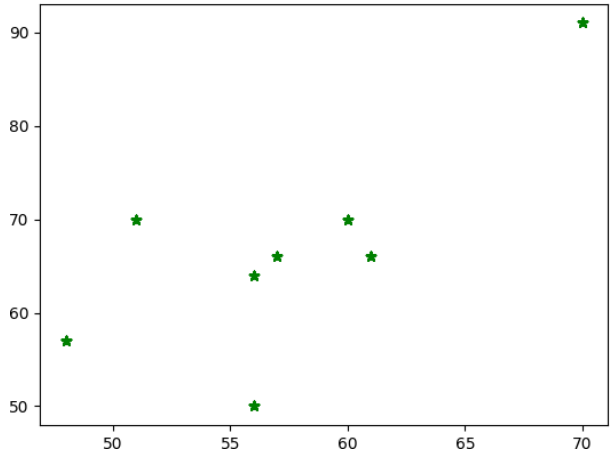

Fig 11: Scatter plot environment condition of the student

The above Scatter plot is taken for “Attention” and “Meditation” values for student 1 in the Environment condition. From the above graph, we can observe that the number of stars obtained is equal to the different values of the data which has collected in the Environment condition from Student 1. As we can say that Student 1 has more Attention and Meditation in the Environment condition when compared to Class and Noisy conditions, so we have obtained less number of stars than the number of stars obtained in the Noisy condition. Hence, we can say that Student 1 has more Attention, Meditation, and less distraction in the Noisy condition. Hence, we can say that Student 1 has more Attention, Meditation, and less distraction in the environmental condition.

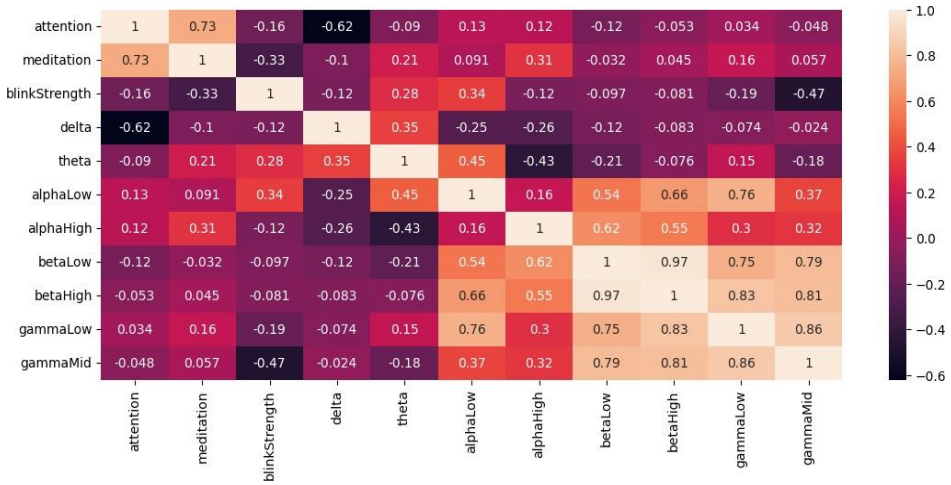

Fig 12: Heat map environment condition of the student

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ISO 3297:2007 Certified ⁜ Impact Factor 8.066 ⁜ Peer-reviewed / Refereed journal ⁜ Vol. 10, Issue 5, May 2023

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The above graph depicts the heat map for student 1 in the environmental condition. Here as it shows the correlation between various features through color-coding we can infer that the student didn't have much attention and meditation and the correlation between various attributes but it improved as time progressed. This can be clearly observed through the graph wherein in the initial stages we can observe the dark color coding but as we move further, we can observe it becomes lighter which means that the coordination among various attributes has increased and the student is having high attention level in this environmental condition.

Noise condition

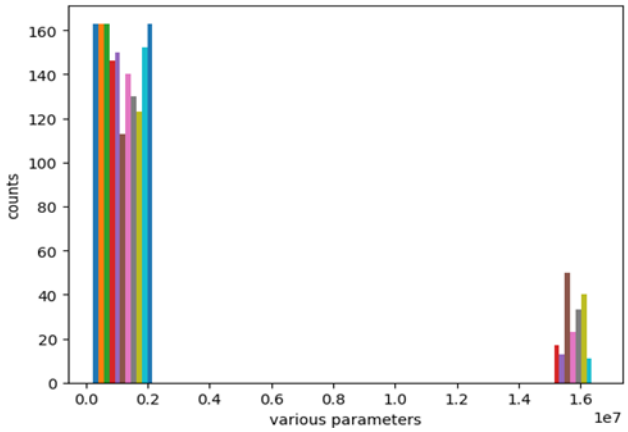

Fig 13: Histogram for noise condition of the student

As we can see in the graph that shows the various parameters associated with student's ongoing brain activity in canteen condition also can be called as noisy condition. Here all the parameters are continuously varying having different values for sleepiness, creativity, decision-making processes etc. But also has a certain amount of attention, meditation and blink strength which means the student is active but is not indulged in creative thinking or other cognitive ability activities in the canteen or the noisy condition.

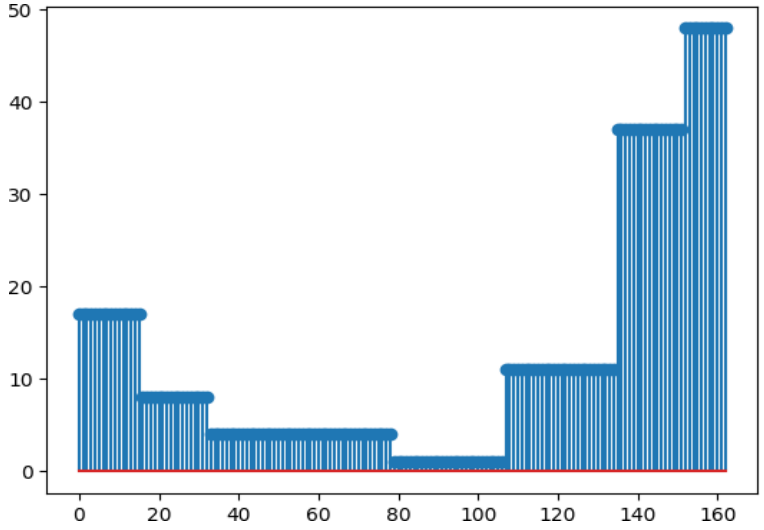

Fig 14: Stem plot noise condition of the student

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁜ Impact Factor 8.066 ⁜ Peer-reviewed / Refereed journal ⁜ Vol. 10, Issue 5, May 2023

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Finally, we arrive at the stem plot of student 1 in canteen condition or in the noisy condition. Here it is very evident from the graph that this student is having varying attention levels on this condition where some of the data have zero level concentration and some others have even average values for attention as shown in the above graph. Therefore, for this graph, we can infer that this student doesn't have a stable attention level in this canteen or the noisy condition. Hence, we can conclude from all the above graphs that this student has a stable attention level in environmental conditions rather than the other two conditions that is class condition and environment condition.

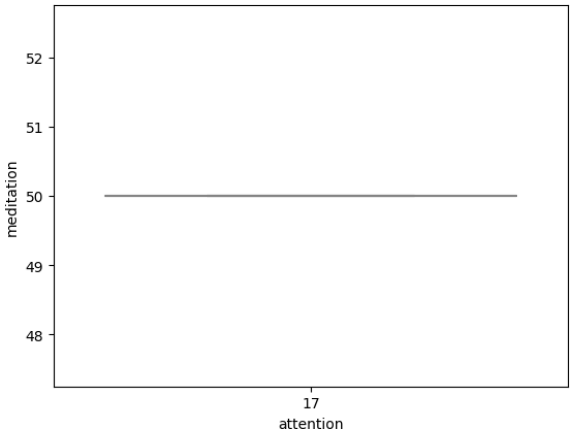

Fig 15: Box plot noise condition of student

The above graph depicts the box plot for noisy conditions wherein we can observe that the student has very low attention value and at the same time we also have very low coordination between attention and meditation as shown by the horizontal line passing the graph. Hence, we can infer that the student doesn't have much attention level in this canteen condition. Therefore, from all the
above three variant conditions in box plot, we can conclude that the student has much attention, and learning capabilities in the environmental condition.

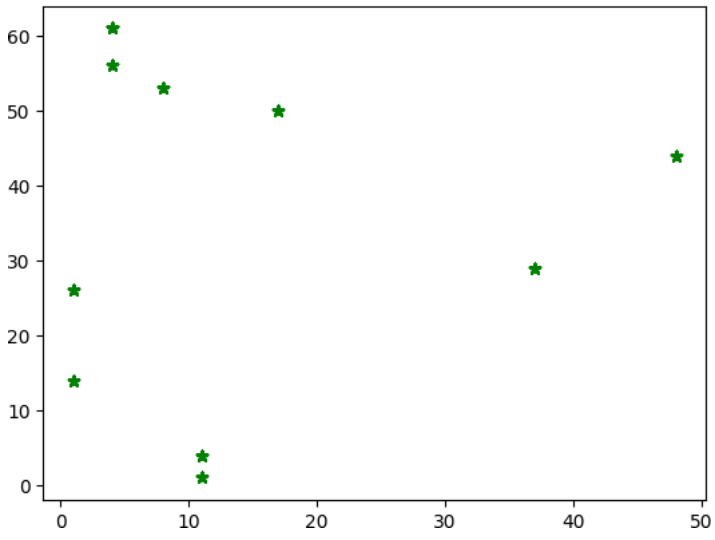

Fig 16: Scatter plot noise condition of the student

The above Scatter plot is taken for "Attention" and "Meditation" values for Student 1 in the Noise condition. From the above scatter plot, we can observe that the number of stars obtained are equal to the different values of the data which has obtained in the Noise condition from Student 1. As we can say that Student 1 has less Attention and Meditation in the Noisy condition, because we have obtained a greater number of stars in the scatter plot i.e., more noise (distraction) means more varying attention and meditation values, i.e., more stars. Hence, we can say that Student 1 has less Attention, Meditation, and more variations in the Noisy condition.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

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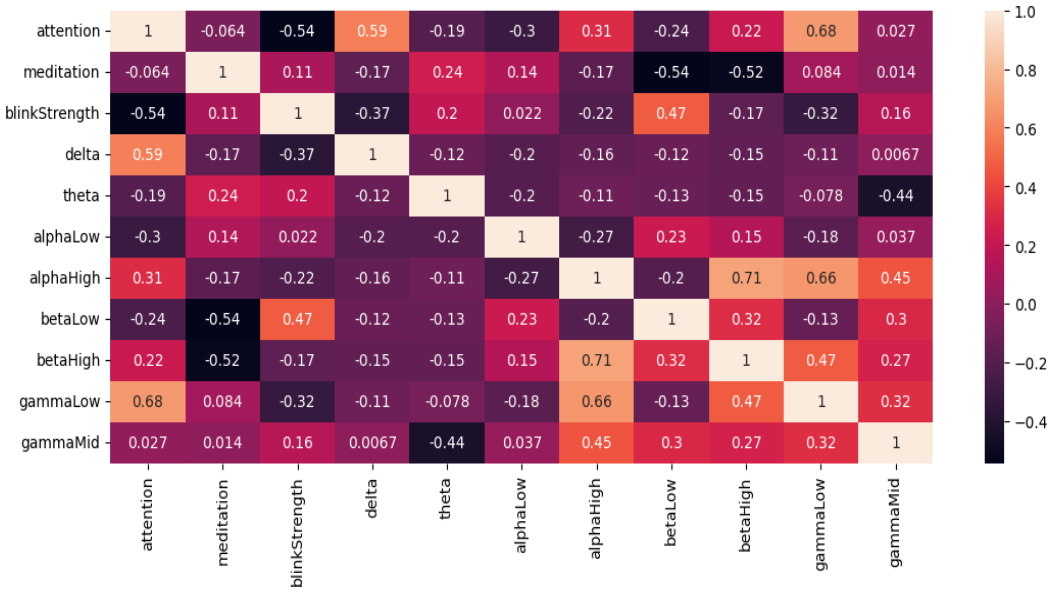

Fig 17: Heat map noise condition of student

Now this graph depicts the heat map for Student 1 in Noise conditions. Here we can observe that in the Noise condition, no correlation exists between the parameters. Almost the whole graph can be seen as the dark color coding in the heat map i.e., negative values. Hence, we can infer that the student is neither has more Attention nor Meditation level. Hence in Noise condition Student cannot able to keep focus on a particular thing, due to noise and distractions student attention, concentration, and meditation level will be reduced.

VII. CONCLUSION

The “Performance Analysis of Learning Capabilities of Students in an ambient atmosphere using BCI” project has the ability to significantly enhance our understanding of how cognitive performance is impacted by environmental factors and also how BCI technology is used to estimate and improve cognitive performance in various learning environments. By achieving its objectives, the project is able to bestow the development of more efficient and effective educational systems and improve the learning outcomes for students.

This project presents several advantages, including more accurate computations and more objectives of cognitive performance, potential for future research and development, potential for personalized learning interventions, and improved learning outcomes. The applications of the project are wide and have the ability to enhance learning outcomes and the standard of living for individuals in a variety of settings.

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IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

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