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A Measure for Measure: Statistics in Education

Anasuya Adhikari[1], Prasanta Gayen[2], Aniket Sutradhar[3], Dr. Subir Sen[4]

[1]*Ph.D. Research Scholar Department of Education, Sidho-Kanho-Birsha University, India*
[2]*Ph.D. Research Scholar Department of Education, Sidho-Kanho-Birsha University, India*
[3]*Ph.D. Research Scholar Department of Education, Sidho-Kanho-Birsha University, India*
[4]*Associate Professor Department of Education, Sidho-Kanho-Birsha University, India*

ABSTRACT

The goal of the current study was to provide a thorough analysis of the applications of Mahalanobis Distance, Cluster Analysis, and Correlation Coefficients. Starting with the presumption that all three statistics can be used to identify causation, several analyses and interpretations are examined. The use of this statistical instrument in the area of educational research over the past ten years is thoroughly examined. We hope that by sharing our work, people will be motivated to pay more attention to the inferential statistics that are most frequently employed in the field of educational research.

Keywords: Mahalanobis Distance, Correlation, Cluster Analysis, Measurement, Measurement Analysis

Introduction

The use of statistical techniques to analyse and understand data in the education sector is referred to as statistics in education. This information can include a wide range of topics, which would include psychological, social or economic issues. Researchers, teachers, administrators and policy makers might decide intelligently on curriculum, teaching strategies, budget allocation, and much more by employing statistical analysis. Users using multi-dimensional analysis can view data from a variety of angles. They can identify patterns or outliers in the data. A hierarchy is a set of connected dimensions that are organised. Cluster Analysis, Mahalanobis Distance and Correlation are new and effective means of data analysis in the field of educational research.

Discussing Cluster Analysis, Mahalanobis Distance and Correlation

Two-step cluster analysis is a technique that can be applied to both categorical and continuous variables when there are categorical variables with three or more categories. A technique that just takes one iteration through the data is two-step cluster analysis. When deciding whether to construct a new cluster or to add an observation to an existing one, the distance criteria are utilised. These fresh observations are grouped utilising the hierarchical cluster approach. The number of clusters can either be predetermined or determined by the algorithm of the two-step cluster analysis. The approach grows increasingly accurate as the number of subclusters increases (Adhikari et al. 2023).

A measure of the distance or divergence between groups in terms of particular criteria can be done by Mahalanobis Distance. It has been extensively measured and has contributed significantly to statistics and data analysis. Two-step cluster analysis is a technique that can be applied to both categorical and continuous variables when there are categorical variables with three or more categories. A technique that just takes one iteration through the data is two-step cluster analysis. When deciding whether to construct a new cluster or to add an observation to an existing one, the distance criteria are utilised. These fresh observations are grouped utilising the hierarchical cluster approach. The number of clusters can either be predetermined or determined by the algorithm of the two-step cluster analysis. The approach grows increasingly accurate as the number of subclusters increases.

A correlation is a statistical method used to determine whether a relationship between two variables exists. In order to determine the factors most directly connected to a specific piece of knowledge or mentality, this strategy looks at indirect connections. It entails evaluating how well the line matches them using the data. Correlation analysis is a statistical method for describing how strongly two variables are related to one another. The following are examples of how this statistical tool has been used in educational research over the past ten years (Sutradhar et al. 2023).

Literature Review

1. **Mahalanobis Distance**

Ahmed et al. (2020) conducted a study on *"Application of Mahalanobis Δ2 on achievement tests on mathematics: A study on higher secondary level students"* to study the challenge of the nature of mathematical accomplishment for two groups of higher secondary level students and found that there is

a comparable downward trend in mathematical achievement for two groups of students from various universities. **Ahmed et al. (2021)** conducted a study on *"Comparison of achievement of higher secondary subjects among tribal and non-tribal students of Bodoland Territorial Region, Assam, India using Mahalanobis distance"* to assess academic achievement in the four areas of biology, physics, chemistry, and mathematics of two sets of pupils from the Bodoland Territorial Region (BTR), Assam, India. Three separate dichotomous types of groupings are produced: tribal against non-tribal, male versus female, and rural versus urban. There is no discernible difference in the dynamical nature of achievement for any of the aforementioned groupings. **Ahmed et al. (2022)** conducted a study on *"Comparison of scholastic attainment in English and Math amongst other studies at the higher secondary level: A study using Mahalanobis distance"* to compare the academic performance of two groups of higher secondary students in the Bodoland Territorial Region (BTR) regions of Assam, India, across five different academic disciplines, including mathematics, English, biology, physics, and chemistry, and found that there is no difference between urban and rural students in terms of the dynamic character of achievement, despite the fact that urban students received better conditions than rural students. **Ahmed et al. (2022)** conducted a study on *"A comparative study on academic achievement of Mathematics and English with other subjects of secondary level in BTR of Assam, India, using Mahalanobis distance"* to compare the academic achievements of two student groups in the fields of mathematics, English, general sciences, and social studies in the Bodoland Territorial Region (BTR), Assam, India. When the dynamic nature of achievement of different groups, such as students from tribal and nontribal communities, students from rural and urban schools, tribal boys and nontribal boys, and tribal girls and nontribal girls, is taken into account, the results showed that there is no statistically significant difference between boys and girls. **Gorain et al. (2021)** conducted a study on *"A study on internet dependency, social isolation and personality using Mahalanobis distance"* to compare a variety of psychological factors, including Internet Dependency, Social Isolation, and five different personality factors of postgraduate level students using the Mahalanobis Distance and found no appreciable differences in the dynamic nature of male and female students, as well as students studying the arts and sciences.

Mahato and Sen (2021) conducted a study on *"Application of Mahalanobis distance to determine the dynamical nature of academic stress, self-efficacy in mathematics and anxiety in Mathematics"* using the Mahalanobis Distance to compare Academic Stress, Math Self-Efficacy, and Math Anxiety, it was discovered that the dynamical nature of the three dependent variables is not significantly different for various sets of independent variables. **Mohanta et al. (2023)** conducted a study on *"Comparison among different dimensions of organizational climate of secondary school teachers of West Bengal by Mahalanobis distance"* the use of Mahalanobis Distance to compare different characteristics of organisational environment, including as employees' opinions of autonomy, manager trust, teamwork, incentives and recognition, fairness, and organisational support. The results demonstrated that the dynamical features of the six dependent variables are identical for different sets of independent variables. **Mohanta et al. (2023)** conducted a study on *"Comparison among different dimensions of institutional commitment of secondary school teachers of West Bengal by Mahalanobis Distance"* applying the Mahalanobis Distance to compare the various facets of institutional commitment, such as affective commitment, professional commitment, commitment to the learner, and academic commitment. The results showed that there was no noticeable variation in the dynamical nature of the dichotomous groupings when four dependent variables were grouped as a branch.

Sen and Pal (2020) conducted a study on *"Mahalanobis distance: A study on achievement of Science and Mathematics"* to examine how two student groups, seventh grade and eighth grade, performed as a group in math, physical science, and biological science in three distinct types of schools. Mahalanobis Distance is assumed to be a dynamic indicator of student achievement across three subjects for two learner groups. Distances have been found to frequently have a significant impact on how students perform in a range of topics. **Sen et al. (2023)** conducted a study on *"Comparison among different leadership styles of head of the institution of West Bengal by Mahalanobis distance"* using Mahalanobis Distance, compare several leadership theories including mentoring leadership, visionary leadership, visionary leadership, dominant leadership, and democratic leadership. The results demonstrated that there was no noticeable change in the dynamic nature of the dichotomous categories when five dependent variables were joined as a branch. **Sen et al. (2023)** took up a study *"Comparison among self-efficacy, Depression, Anxiety and stress of postgraduate students by Mahalanobis Distance".* Three different dichotomous groups of students are considered for this study. Mahalanobis Distance is applied to compare the dynamical nature of five dependent variables (general self-efficacy, specific self-efficacy, depression, anxiety and stress) considered as a branch. It is found that there is no significant difference in dynamical nature of five dependent variables for different groups of independent variables. **Adhikari (2023)** has conducted a study on *"Application of Mahalanobis distance in education and educational psychology: A review"*. The research on Mahalanobis distance in education and its enormous potential in educational psychology as of 2020 is examined in this study. The combination of factors, i.e., internet dependence, social isolation, personality, academic stress, self-efficacy and anxiety, and Mahalanobis distance, is computed for drawing inferences in the context of educational psychology.

2. Cluster Analysis

Saha et al. (2021) in their research paper *Analysis of Attitude Towards Yoga Among College Students Using Clustering Techniques* discusses about Yoga. In the study, attitudes towards yoga practise are examined among college students in the Purulia district of West Bengal, India. On a survey measuring students' attitudes towards yoga, 570 undergraduate students' opinions were gathered. This study takes into account one dependent variable, the questionnaire score, together with four independent variables: gender, college location, student residence, and streams. Data clustering is the process of assembling a number of items into a single group such that they are more similar to one another. To conduct the current inquiry, a two-step cluster analysis is used to establish five clusters. **Gorain et al. (2022)** in their research paper *A Study on Relationship and Cluster Analysis among Internet Dependency, Social Isolation and Personality*. The current study examines different psychological characteristics of college students. Investigations are made into the relationships between several variables, including Internet Dependency, Social Isolation, and five different personality traits. Science and the arts are two groups that are considered in this study. In order to achieve the aforementioned objectives, correlations between Internet Dependency, Social Isolation, and five distinct personality factors are looked into for art, science, and all art and science learners. Extraversion, agreeableness, conscientiousness, neuroticism, and openness are among these characteristics. There is a link between each pair of variables that is either very weak or average. Three groups

emerge suddenly. Male and female students in the arts formed two distinct clusters, whereas science students formed a single cluster. **Mohanta et al. (2023)** in their research work *Introspecting Institutional Commitment Using Cluster Analysis* attempts to study the likeness of the responses given by secondary school teachers regarding Institutional Commitment. The study employed a two-step cluster analysis method that creates several groupings based on the universities' locations and the gender of their professors. How the Predictors impact cluster formation is investigated. **Mohanta et al. (2023)** in their research work *Perceptional Environment: A Study on Organizational Climate Using Cluster Analysis* has under taken 400 Secondary School Teachers through Stratified Random Sampling. The results showed that gender affected assumptions about the institutional atmosphere. The two facts above could be taken to mean that responses to institutional contexts depend on both gender and the location of the institution. **Sen et al. (2023)** in their research *Clustering Technique for Analysing Leadership Style of the Head of the Institutions* compares the responses provided by Head of the Institutions on Leadership style. There are several clusters produced by the study's two-step cluster analysis method, with the institutions' locations acting as a key cluster predictor. How the Predictors impact cluster formation is investigated. Each cluster was formed differently in relation to the predictors. The results showed that the number of predictors rose along with the number of Clusters. Additionally, it was found that place ends up being the main predictor. Similar views on leadership styles have been found depending on where the institutions are located.

3. Correlation

Saha (2012) has investigated *Creativity in relation to socio-economic status in secondary school students in West Bengal* on 100 secondary students, selected randomly from Birbhum District in West Bengal and found that creativity is positively corelated with socio-economic status. **Saha (2013)** has studied *Creativity in relation to environmental awareness in Birbhum district: An analytical study* selecting randomly 300 secondary students of Birbhum District in West Bengal and explored that creativity is positively co-related with environmental awareness. **Kundu, Saha and Mondal (2015)** have studied *Adjustment of undergraduate students in relation to their social intelligence* and found significant relationship between social intelligence and adjustment of U.G. level students of different colleges under the Sidho-Kanho-Birsha University, Purulia.

Karmakar et al. (2016) have studied *Intelligence in relation to height and weight among secondary school students* on randomly selected 97 female and 112 male students from five secondary schools in Purulia district and revealed significant relationship between IQ and height; and low significant relationship between IQ and weight; and also, no significant relationship between IQ and BMI. **Kar, Saha and Mondal (2016)** have investigated *Emotional intelligence and adjustment ability among higher secondary school students: A correlational study* on randomly selected 302 samples in Purulia, WB, India and found that Emotional Intelligence affects home, school and peer adjustment through Pearson coefficient correlation.

Gorain et al. (2018) have studied *Social isolation in relation to internet usage and stream of study of under graduate students* and found that while there is no discernible difference in internet usage between humanities and science graduate students, high internet users are more socially isolated than ordinary and low internet users. Internet use and social isolation are found to be positively correlated, with a Pearson coefficient of correlation of 0.326. **Mondal et al. (2018)** have studied *Internet affinity in relation to personality and gender* and found that neuroticism is highly correlated with internet affinity, whereas the other four personality factors are either negatively correlated with internet affinity or are not correlated at all, and that males have a higher internet affinity than their female counterparts. **Kar and Saha (2021)** have studied *Leadership style and Adjustment Ability among Undergraduate Students: A Correlational Study* and revealed significant relationship by Pearson's method between Emotional Intelligence and Leadership style of undergraduate students of West Bengal.

Gayen and Sen (2021) have studied *Prevalence of anxiety, depression and stress among postgraduate students during COVID-19 situation: A study on postgraduate students* found the relationship between anxiety and depression for the female students, stress and depression for the female students, anxiety and depression for the students of depression, anxiety and education department for the students of other department, anxiety and depression for the students of 2nd semester and depression and anxiety for the students of 4th semester are significant. Other than these, no other aspects exhibit any other notable links. **Kar and Saha (2021)** have studied *Leadership style and Adjustment Ability among Undergraduate Students: A Correlational Study* and found significant relationship between Adjustment Ability and Leadership style of undergraduate students of West Bengal. **Sutradhar and Sen (2022)** have conducted a study *Emotional maturity and study habits of B.Ed. trainees – A correlational study* on Birbhum district of West Bengal and found significant relationship between emotional maturity and study habits. The significance relationship also found for the same variables between male and female, private and govt. trainees and rural. But, for urban trainees no significant relationship was found. **Gorain et al. (2022)** have investigated *A study on relationship and cluster analysis among internet dependency, social isolation and personality* and found positive relationship between Internet Dependency and Social Isolation.

Sutradhar and Sen (2022) have studied *Effect of Different Dimensions of Emotional Maturity on Academic Achievement of B.Ed. Trainees – A Study* but not found a significant relationship between emotional maturity and academic achievement of B.Ed. trainees in their study on B.Ed. trainees. **Mahato and Sen (2023)** investigated *Relationship among Contexts Knowledge (CK1), technological pedagogical content knowledge (TPCK) and attitude towards creative teaching for pre-service trainee teachers: A study on Mathematics method subject* and found significant relationship in most of the cases. **Mahato, Gayen and Mahato (2023)** have studied *Relationship between self-efficacy and m-learning of undergraduate students of Purulia district of West Bengal* and indicated that there is no correlation between undergraduate students in the Purulia area of West Bengal's self-efficacy and m-learning. It also showed that self-efficacy and mobile learning are unaffected by gender or place of residence. **Mahato, Gayen and Mahato (2023)** have studied *Relationship between academic resilience and internet addiction of undergraduate students of Purulia district of West Bengal: A study* and found significant relationship of internet addiction between boys and girls, but no difference has been found in academic resilience. Locality has no discernible influence on either academic toughness or internet addiction. **Mahato, Gayen and Mahato (2023)** have studied *Relationship between Cognitive Failure and Internet Addiction of Higher Secondary Students of Purulia District of West Bengal: A Study* and discovered a substantial

association between cognitive failure and internet addiction among pupils in West Bengal's higher secondary Purulia area. However, no substantial differences in cognitive failure and internet addiction have been reported in terms of gender, region, or stream.

Conclusion

For a specific collection of experimental data or real-world research, statistics is a type of mathematical analysis that makes use of quantified models, representations, and synopses. To collect, examine, evaluate, and derive conclusions from data, statistics practically plays very important role in research methodology. Research in statistics finds application in almost of the scientific domains, and research concerns in the various scientific fields inspire the creation of new statistical methods and theories. Statistics has great importance in education. Users of multi-dimensional analysis have access to a wide range of perspectives on the data. They can spot anomalies or patterns in the data. In the area of educational research, innovative and powerful techniques for data analysis include cluster analysis, Mahalanobis distance, and correlation. A statistical technique called correlation is used to evaluate a potential linear link between two continuous variables. Both the calculation and interpretation become easy in this case. Mahalanobis Distance can be used as a strong measure in terms of a single dimensionless number for comparing several sets of data taken together as a unit. Cluster analysis is a technique for creating organized collections of patterns into groups based on their similarity of some property or action.

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