

## Application of Mahalanobis Distance in Education and Educational Psychology: A Mini Review

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### Abstract

Mahalanobis distance is a metric for the distance between groups regarding specific criteria. Mahalanobis distance is a measurement between two data sets in the space delineated by specific attributes. It will accurately assess the distance by giving various essential factors to the characteristics of data points since it considers variances and correlations between characters. Mahalanobis distance has an essential use in education in terms of achievement analysis. Mahalanobis distance is a powerful tool for drawing inferences between two groups of several variables. As it is a dimensionless, single number, it is easy to understand and interpret. Since this is a powerful tool, the application of Mahalanobis distance will increase rapidly to draw the inference. The paper examines the literature on Mahalanobis distance in education and its massive potential in educational psychology since 2020.

**Keywords:** Mahalanobis distance, achievement analysis, educational psychology, education, inferential statistics

### Introduction

Mahalanobis distance is a metric for the distance or divergence between groups regarding specific criteria. As part of his research on racial resemblance, P. C. Mahalanobis suggested this measure in 1936 (Mahalanobis, 1936). With numerous measurements, it has played a fundamental and significant role in statistics and data analysis. The Mahalanobis distance is a measurement between two data sets in the space delineated by pertinent attributes. Giving various essential factors to the data points' characteristics will accurately assess the distance since it considers various character variances and correlations. If a proper Mahalanobis distance metric is provided, such benefits can be exploited for specific tasks on a particular data set.

The study aims to make future researchers aware of such an area of study which can help them to analyze data using a strong measure like Mahalanobis distance.

### Decoding Mahalanobis Distance: Studying the Existing Literature in Education

The use of Mahalanobis distance in education was introduced by Eusob Ali Ahmed, Dr. Munmun Banerjee, Dr. Subir Sen, and Prof. Prasanta Chatterjee in 2020. Since then, there have been many works in education and educational psychology till 2022. These works have been studied here to understand the importance and necessity of such a vital measure, which measures several variables between two groups by determining a single dimensionless number.

Ahmed et al. (2020), in their application of Mahalanobis  $\Delta_2$  on achievement tests on mathematics: A study on higher secondary level students, talks about the nature of mathematical achievement for two groups of higher secondary level pupils, is the subject of a study project. The subject area of the study is evaluation in education. This study aimed to determine the differences in math achievement for various students in various grades at the higher

secondary level in Assam, India. Two sets of data were prepared for calculating distance. For the first set, learners of 11th grade were taken. The final results of the secondary level and the scores of an achievement test for 11th grade constructed by the authors were considered for analysis by stratified random sampling. The achievement problem was investigated using descriptive and inferential statistics such as central tendency, correlation, *t*-test, and Mahalanobis distance. A study used performance in the 10th, 11th, and 12th grades for two academic years and universities. The Mahalanobis distance measures the dynamic character of student achievement in two groups. The findings show that mathematical achievement for two groups of students from different colleges is declining similarly.

Sen & Pal (2020), in their Mahalanobis distance: A study on achievement of science and mathematics talk about another piece of research examining how achievement-related problems can be analysed using the Mahalanobis distance method recognized. The subject area of the study is evaluation in education. Two sets of data for three schools were prepared for calculating the distance, first, for seventh-grade learners. Here, scores in three subjects, i.e., Mathematics, Physical Science and Life Science, are considered for formative and summative tests. Second, similar data sets for eighth grade were prepared by stratified random sampling. The issue is the achievement of two student groups, seventh and eighth graders, from three different types of Mathematics, Physical Science, and Life Science schools. Mahalanobis distance tests the dynamical nature of student achievement in three subjects for two groups of learners. It was found that, in most cases, there are considerable differences in the achievement for the group of subjects between the various student groups.

Mahato & Sen (2021), in their research work application of Mahalanobis distance to determine the dynamical nature of academic stress, self-efficacy in mathematics and anxiety in mathematics worked on two groups of students in higher secondary education, a work dealt with the application of Mahalanobis distance to quantify the difference between the

dependent variables academic stress, self-efficacy in mathematics and anxiety in mathematics. The subject area of the study is educational psychology. For this study, eleven independent student factors are divided into five distinct dichotomous categories. Three dependent variables are compared using the Mahalanobis distance to assess their behavior using stratified random sampling dynamically. The findings said that the dynamic nature of the three dependent variables for various groups of independent variables is not significantly different.

Gorain et al. (2021), in their paper on a study on internet dependency, social isolation and personality using Mahalanobis distance, talks about how hominids have evolved to trust and depend on the internet with the arrival of the globalised 21st century. There is a burdensome reliance on this media in all spheres, from education to shopping. The subject area of the study is educational psychology. On the other hand, this rapid development of the internet is bad enough since it significantly negatively impacts the human personality and forces people to withdraw from society. With the aid of Mahalanobis distance, a study compares many psychological features of postgraduate students. This study considers several variables: internet dependency, social isolation, and five different personality factors. Various groups have been developed for a study, including science and the arts, men and women. Two hundred fifty PG students of Sidho-Kanho-Birsha University were taken as samples. The sample is collected by a simple random sampling method. Two dichotomous independent variables—Gender (Man and woman) and stream (arts and science) – are taken as a branch for two dependent variables—internet dependency, social isolation, extraversion, agreeableness, conscientiousness, neuroticism, and openness and Mahalanobis distance  $s$  are calculated. The findings concluded that there are no appreciable disparities in the dynamic nature of man and woman students and students studying the arts and sciences.

Ahmed et al. (2021) studied the comparison of achievement of higher secondary subjects among tribal and non-tribal students of Bodoland Territorial Region (BTR), Assam, India using Mahalanobis distance. The current investigation compares performance in four distinct disciplines, namely. BTR, Assam, India, students from two groups competed in Biology, Physics, Chemistry, and Mathematics. The subject area of the study is evaluation in education. Three dichotomous groups are formed: Boys against girls, tribal versus non-tribal, and rural versus urban. A stratified random sampling technique was followed for the collection of data. Eight Hundred ninety four tribal and 684 non-tribal students were considered, who passed higher secondary in 2020 (average age approximately 18 years) were selected from BTR, and marks of higher secondary examinations in Biology, Physics, Chemistry and Mathematics were collected. In order to compare the dynamic character of achievement between two groups of students in four topics, the Mahalanobis distance is used. The study's findings showed that the dynamical character of achievement for all the groups mentioned above shows no discernible variation.

Ahmed et al. (2022a), 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, deals with a current study comparing the academic performance of two student groups in the BTR, Assam, India, in four different subject areas: Mathematics, English, General Sciences and Social Studies. The subject area of the study is evaluation in education. Boys and girls from different secondary and higher schools of BTR are divided into three different types of categories, including tribal and non-tribal, rural and urban, and tribal and non-tribal, using stratified random sampling. To compare the dynamic character of success between two groups of students in four disciplines, Mahalanobis distance is utilized. The findings showed no significant difference between boys and girls when students from rural and urban schools, students from tribal and non-tribal communities, tribal boys and non-tribal boys, and tribal and non-tribal girls were considered.

Ahmed et al. (2022b), in their research work, comparison of scholastic attainment in English and Math amongst other studies at the higher secondary level: A study using Mahalanobis

distance shows an investigation on how the Mahalanobis distance is used to compare the academic performance of two groups of higher secondary students in the BTR, the Indian state of Assam in five different subject areas, including Mathematics, English, Biology, Physics, and Chemistry. Students from tribal and non-tribal origins, boys and girls, urban and rural, urban boys and rural boys, and urban girls and rural girls are just a few of the five sorts of groupings that are considered. The subject area of the study is evaluation in education. The Mahalanobis distance is used in five fields to calculate the variance in the dynamic nature of student achievement between two sections. The study is based on a sample of 1504 Grade 12th students from tribal and non-tribal backgrounds, as well as boys and girls from rural and urban areas, who took English, Mathematics, Biology, Chemistry, and Physics subjects and passed in the year 2020, and 32 higher secondary schools, junior colleges, and colleges are chosen using a stratified random sampling technique. Despite urban students having superior conditions to rural students, there is no difference between urban and rural students in terms of the dynamic character of achievement. Similar findings have been found for both urban and rural girls and urban and rural boys. Additionally, it is discovered that there is no statistically significant difference between boys and girls or between tribal and non-tribal students.

### Conclusion

For the past few decades, Mahalanobis distance has been crucial in separating traits in fields such as anthropology, physics, precision medicine, clustering, image processing, classification, and neurocomputing. Currently, this distance is used in educational studies when the dynamical measurement of a set of variables is considered for two or one groups of learners where a group of variables is taken in two separate scenarios.

Mahalanobis distance is used for achievement analysis in education. It is a powerful tool for drawing inferences between two groups of several variables. As it is a dimensionless single number, it is easy to understand and interpret. Considering the case of educational psychology, the combination of variables, i.e., internet dependency, social isolation, personality, academic stress, self-efficacy and anxiety, and Mahalanobis distance, is computed for drawing inference. There can be many more variables that can be used to calculate Mahalanobis Distance. Since this is a powerful tool, the application of Mahalanobis Distance will increase rapidly to draw the inference.

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