

Feature Selection of Student Performance Parameters using Statistical Techniques

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Abstract-

Student information system holds a lot of information regarding demographic information and academic information of the students. It is very difficult to find out the highest affected parameters on student performance. This work aim is to perform statistical analysis and highlight the factors affected on the performance of students. We applied chi-square statistics technique to find out the most relevant academic and non-academic factors. This analysis is carried out by comparative analysis of various hypothesis testing. The outcome of this analysis would help the management to take timely and proactive decisions to improve the performance of students.

Keywords: Statistics, Chi-square, hypothesis testing, Student Performance

I. INTRODUCTION

Student database has very large datasets that involve many demographic and academic attributes. Student dataset involves many attributes those highly affected on student performance and some attributes are less affected on performance of students. In the Indian scenario the attributes of student dataset that affect performance is different from the students of foreign universities. Students in India do not come in different age groups nor there retention problems in courses. Online courses are very few in India. The attributes that influence a student's performance are entirely different in India. This research work is carried out by applying chi square technique on student dataset to identify the most probable factors contributing to the success of students in a course.

II. RESEARCH OBJECTIVE

The main goal of this research is to analyze the student data of UG Computer courses and identify the key performance indicators that affect the result of the student in the course.

III. ABOUT CHI-SQUARE STATISTICAL TECHNIQUE.

A. Why Chi-Square?

Chi-Square Analysis Pearson's chi-square test of independence is a statistical method used to identify degree of association between variables [1]. This technique is applied to analyze the dependency of all attributes (factors) on the outcome attribute.

B. When To Use Chi-Square Test?

The test procedure is appropriate when the following conditions are met:

- The sampling method is simple random sampling.
- The variables under study are each categorical.
- If sample data are displayed in a contingency table, the expected frequency count for each cell of the table is at least 5.

C. Steps And Procedure To Analysis of Chi Square Test:

This approach consists of four steps: (1) state the hypotheses, (2) formulate an analysis plan, (3) analyze sample data, and (4) interpret results.

State the Hypotheses

Suppose that Variable A has r levels, and Variable B has c levels. The null hypothesis states that knowing the level of Variable A does not help you predict the level of Variable B. That is, the variables are independent.

H_0 : Variable A and Variable B are independent.

H_a : Variable A and Variable B are not independent.

The alternative hypothesis is that knowing the level of Variable A *can* help you predict the level of Variable B.

Formulate an Analysis Plan

The analysis plan describes how to use sample data to accept or reject the null hypothesis. The plan should specify the following elements.

- Significance level. Often, researchers choose significance levels equal to 0.01, 0.05, or 0.10; but any value between 0 and 1 can be used.
- Test method. Use the chi-square test for independence to determine whether there is a significant relationship between two categorical variables.

Analyze Sample Data

Using sample data, find the degrees of freedom, expected frequencies, test statistic, and the P-value associated with the test statistic. The approach described in this section is illustrated in the sample problem at the end of this lesson.

- **Degrees of freedom.** The degrees of freedom (DF) is equal to:

$DF = (r - 1) * (c - 1)$ Where r is the number of levels for one categorical variable, and c is the number of levels for the other categorical variable.

- **Expected frequencies.** The expected frequency counts are computed separately for each level of one categorical variable at each level of the other categorical variable. Compute $r * c$ expected frequencies, according to the following formula.

$$E_{r,c} = (n_r * n_c) / n$$

where $E_{r,c}$ is the expected frequency count for level r of Variable A and level c of Variable B, n_r is the total number of sample observations at level r of Variable A, n_c is the total number of sample observations at level c of Variable B, and n is the total sample size.

▪ **Test statistic.** The test statistic is a chi-square random variable (X^2) defined by the following equation.

$$X^2 = \sum [(O_{r,c} - E_{r,c})^2 / E_{r,c}]$$

where $O_{r,c}$ is the observed frequency count at level r of Variable A and level c of Variable B, and $E_{r,c}$ is the expected frequency count at level r of Variable A and level c of Variable B.

▪ **P-value.** The P-value is the probability of observing a sample statistic as extreme as the test statistic. Since the test statistic is a chi-square, use the Chi-Square Distribution Calculator to assess the probability associated with the test statistic. Use the degrees of freedom computed above.^[4]

IV. DATA COLLECTION AND METHODOLOGY

For this study, recent real world data were collected from various UG Collages of Computer Courses. A sample of 3558 students was taken from a group of 10000 student’s records. Selection of students was at random.

The data was collected using a questionnaires’ which includes questions related to demographics, learning behavioral and related to the student’s results. This questionnaire was developed in Google Spreadsheet shared among the students of various institute of computer courses to collect the students’ data. This questionnaires’ was also uploaded on site and shared among the students for collection of student data. Data was collected based on following parameters. There are total 232 attributes. Attribute list is described as per the following.

Table 1: List of Parameters

| Parameters | Data Type | Parameter Values |
|-----------------|-----------|---|
| Srno | Numeric | None |
| Gen | Numeric | {1- Male, 2-Female}... |
| Percentagehsc | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| Stream | Numeric | 1-Commerce, 2-Science |
| F_annual_income | Numeric | 1-Low, 2-Average, 3-Middle, 4-High, 5-Very High |
| attendance_1 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| attendance_2 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| attendance_3 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, |

| | | |
|--|---------|---|
| | | 5-Excellent |
| attendance_4 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| attendance_5 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| attendance_6 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| Overall_attendance | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| W_L_H | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| W_Li_U | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| D_Re_H | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| E_W_L_U_H | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| sam1_sub_nm1 | String | CLanguage |
| Assignment_Mark_1 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| INT_TH_1 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| INT_PR_1 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| EXT_TH_1 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| EXT_PR_1 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| Result_1_1 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| Sub_Attenance_1 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| Sub_Faculty_Prformance_1 | Numeric | 1-Poor, 2-Average, 3-Good, 4-Very_Good, 5-Excellent |
| Same Procedure will be follow for subjects of all semesters | | |

V. TOOLS ANDTECHNIQUES

We have used SPSS Statistical for analysis of the collected data. Here in the analysis we have used random sampling method for selection of the data. In the data collection, data are categorical so most preferable technique for analysis of the data is chi-square statistical technique.

To Select Chi-Square Technique from SPSS tool we have to go through following steps:

- A. Formulate a hypothesis about your variables
- B. Select crosstabs
 - Click on the “Analyze” tab at the top of the page
 - Select “Descriptive Statistics” from the list
 - Select “Crosstabs”
- C. Select your variables for the test
- D. Select the chi-square statistic from the “Statistics” button
- E. Select column percentages from the “Cells” button
- F. Examine the results

VI. RESULTS ANDDISCUSSION

A total of 3558 records were taken randomly for the analysis. In this study, Chi-Square technique is used for analysis of randomly selected and categorical data. Chi-square test is one of the simplest and most widely used parametric as well as non-parametric we used Chi-square test to find the significance between the different attributes and grade obtained by student.

We have prepared following hypothesis to find out highly affected parameters on student performance.

A. Hypothesis1: Is that any Relationship exist between students learning behavior on result or not?

INDEPENDENT VARIABLE: WEEKLYLIBRARYHOURS, WEEKLYLAB USAGE, DAILYREADINGHOURS, EXTRA USAGE OF LIBRARYAND LAB

DEPENDENT VARIABLE: RESULT OF ALL SEMESTERS.

H0 (Null Hypothesis): Students Behavioral parameters are Independent (Not Dependent) on Students Result of all the semester.

H1 (Alternative Hypothesis): Students Behavioral parameters are Dependent on Students Result of all the semester.

Table 2: Chi Square Analysis for Student behavior parameter vs. all semester results.

| SEM | HT | DF | CV | SIG | CO V | RE |
|------------|--------|----|---------|------|--------|----------|
| FIRST SEM | W_L_H | 16 | 81.394 | 0 | -0.074 | Rejected |
| SEC SEM | W_L_H | 16 | 87.806 | 0 | -0.023 | Rejected |
| THIRD SEM | W_L_H | 16 | 126.064 | 0 | 0.007 | Rejected |
| FOURTH SEM | W_L_H | 16 | 110.876 | 0 | -0.04 | Rejected |
| FIFTH SEM | W_L_H | 16 | 64.018 | 0 | -0.042 | Rejected |
| SIXTH SEM | W_L_H | 16 | 107.153 | 0 | -0.07 | Rejected |
| FIRST SEM | W_Li_U | 16 | 118.437 | 0 | -0.007 | Rejected |
| SEC SEM | W_Li_U | 16 | 26.714 | 0.45 | 0.008 | Accepted |
| THIRD SEM | W_Li_U | 16 | 96.861 | 0 | -0.044 | Rejected |

| | | | | | | |
|------------|-----------|----|---------|-------|--------|----------|
| FOURTH SEM | W_Li_U | 16 | 74.218 | 0 | 0.056 | Rejected |
| FIFTH SEM | W_Li_U | 16 | 46.071 | 0 | -0.029 | Rejected |
| SIXTH SEM | W_Li_U | 16 | 70.518 | 0 | 0.006 | Rejected |
| FIRST SEM | D_R_H | 12 | 58.967 | 0 | 0.053 | Rejected |
| SEC SEM | D_R_H | 12 | 13.092 | 0.362 | -0.002 | Accepted |
| THIRD SEM | D_R_H | 12 | 59.29 | 0 | 0.014 | Rejected |
| FOURTH SEM | D_R_H | 12 | 54.122 | 0 | 0.049 | Rejected |
| FIFTH SEM | D_R_H | 12 | 74.752 | 0 | -0.053 | Rejected |
| SIXTH SEM | D_R_H | 12 | 11.518 | 0.48 | 0.021 | Accepted |
| FIRST SEM | E_W_L_U_H | 16 | 112.413 | 0 | 0.004 | Rejected |
| SEC SEM | E_W_L_U_H | 16 | 95.601 | 0 | 0.16 | Rejected |
| THIRD SEM | E_W_L_U_H | 16 | 97.82 | 0 | 0.86 | Rejected |
| FOURTH SEM | E_W_L_U_H | 16 | 76.886 | 0 | 0.57 | Rejected |
| FIFTH SEM | E_W_L_U_H | 16 | 66.243 | 0 | 0.54 | Rejected |
| SIXTH SEM | E_W_L_U_H | 16 | 84.804 | 0 | 0.96 | Rejected |

Table 3: Sum of Chi Square value for all behavioral parameters of students.

| Hypothesis | Sum of ChiSquare Value |
|------------|------------------------|
| D_R_H | 271.741 |
| E_W_L_U_H | 533.767 |
| W_L_H | 577.311 |
| W_Li_U | 432.819 |

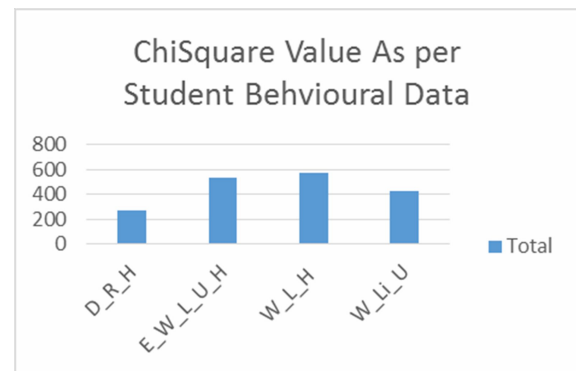


Fig. 1 chart for student behavioral data

B. Hypothesis2: Is this any relationship exist or not, between Internal Theory Exam, Internal Practical Exam, External Theory Exam, External Practical Exam, Assignment Regularity, Subject Attendance Ratio and Faculty performance on Result of All the semesters ?

INDEPENDENT VARIABLE: INTERNAL THEORY MARKS, INTERNAL PRACTICAL MARKS, EXTERNAL THEORY MARKS, EXTERNAL PRACTICAL MARKS, ASSIGNMENT REGULARITY, SUBJECT ATTENDANCE RATIO, FACULTY PERFORMANCE

DEPENDENT VARIABLE: RESULT OF ALL SEMESTERS

H0 (Null Hypothesis): Parameters like Internal Theory and Practical Marks, External Theory and Practical Marks, Assignment Regularity, Subject Attendance Ratio and Faculty performance are independent (Not Dependent) on Result of all the semesters.

H1 (Alternative Hypothesis): Parameters like Internal Theory and Practical Marks, External Theory and Practical Marks, Assignment Regularity, Subject Attendance Ratio and Faculty performance are dependent on Result of all the semesters.

Analysis and Results to prove above hypothesis is as per the following:

First Semester Statistical Analysis:

Table 4: Chi Square analysis for all the subject of first semester

| Chi Square Test for Subject 1 of First Semester | | | | | | |
|---|--------|----|----------|-------|--------|----------|
| SN | HT | DF | CV | SIG | COV | Result |
| CLAN | INT_TH | 16 | 955.364 | 0 | 0.476 | Rejected |
| | INT_PR | 16 | 824.285 | 0 | 0.459 | Rejected |
| | EXT_TH | 16 | 908.8 | 0 | 0.479 | Rejected |
| | EXT_PR | 16 | 891.536 | 0 | 0.453 | Rejected |
| | ASS_M | 16 | 121.343 | 0 | -0.75 | Rejected |
| | ATT_M | 16 | 73.907 | 0 | -0.32 | Rejected |
| | FAC_P | 16 | 85.085 | 0 | -0.004 | Rejected |
| Chi Square Test for Subject 2 of First Semester | | | | | | |
| SN | HT | DF | CV | SIG | COV | Result |
| OFFICE | INT_TH | 16 | 1042.521 | 0 | 0.499 | Rejected |
| | INT_PR | 16 | 762.101 | 0 | 0.432 | Rejected |
| | EXT_TH | 16 | 870.99 | 0 | 0.443 | Rejected |
| | EXT_PR | 16 | 1059.001 | 0 | 0.492 | Rejected |
| | ASS_M | 16 | 61.203 | 0 | -0.021 | Rejected |
| | ATT_M | 16 | 14236 | 0 | 1 | Rejected |
| | FAC_P | 16 | 70.409 | 0 | -0.006 | Rejected |
| Chi Square Test for Subject 3 of First Semester | | | | | | |
| SN | HT | DF | CV | SIG | COV | Result |
| DE | INT_TH | 12 | 637.085 | 0 | 0.388 | Rejected |
| | INT_PR | 12 | 974.338 | 0 | 0.486 | Rejected |
| | EXT_TH | 12 | 886.474 | 0 | 0.466 | Rejected |
| | EXT_PR | 12 | 842.264 | 0 | 0.456 | Rejected |
| | ASS_M | 12 | 79.223 | 0 | -0.005 | Rejected |
| | ATT_M | 12 | 28.317 | 0.005 | 0.03 | Accepted |
| | FAC_P | 12 | 98.075 | 0 | -0.015 | Rejected |

| Chi Square Test for Subject 4 of First Semester | | | | | | |
|---|--------|----|----------|-------|--------|----------|
| SN | HT | DF | CV | SIG | COV | Result |
| CS_I | INT_TH | 16 | 2478.872 | 0 | 0.713 | Rejected |
| | EXT_TH | 16 | 2492.568 | 0 | 0.699 | Rejected |
| | ASS_M | 16 | 135.71 | 0 | 0.017 | Rejected |
| | ATT_M | 16 | 98.31 | 0 | 0.009 | Rejected |
| | FAC_P | 16 | 74.855 | 0 | 0.022 | Rejected |
| Chi Square Test for Subject 5 of First Semester | | | | | | |
| SN | HT | DF | CV | SIG | COV | Result |
| IT | INT_TH | 16 | 2251.24 | 0 | 0.685 | Rejected |
| | EXT_TH | 16 | 2237.629 | 0 | 0.674 | Rejected |
| | ASS_M | 16 | 30.043 | 0.018 | 0.012 | Accepted |
| | ATT_M | 16 | 144.429 | 0 | -0.48 | Rejected |
| | FAC_P | 16 | 110.975 | 0 | -0.007 | Rejected |

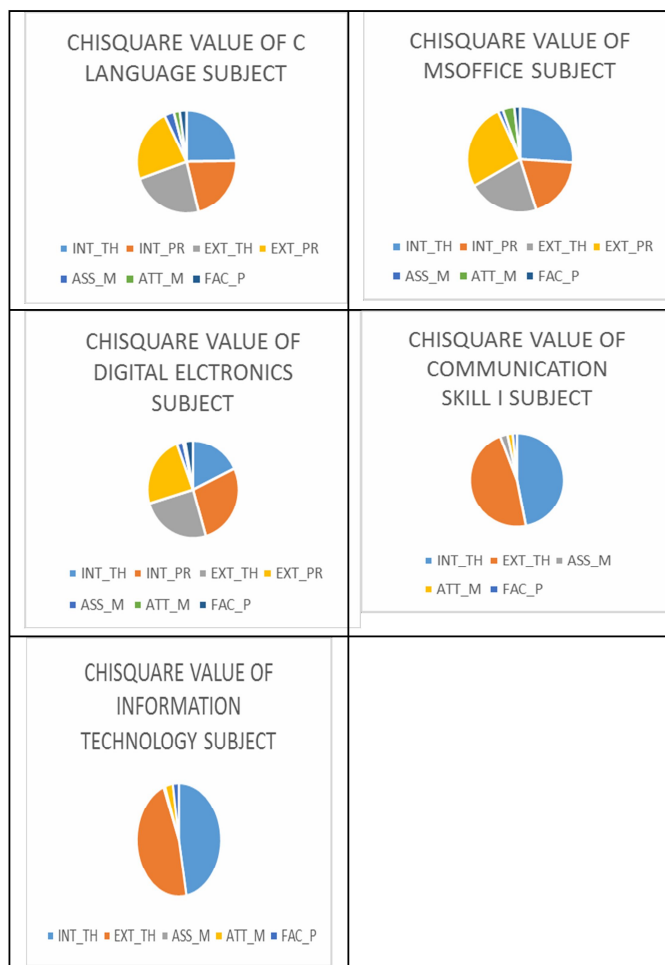


Fig. 2 pie chart for chi square value of all the subject of first semester.

Note 1: Same Mechanism is Repeat for all the Six Semester
Note 2: List of Abbreviation described in appendix A.

C. Hypothesis3: Is this any relationship exist or not, between HSC Percentage, HSC Stream , Father Annual Income and Result of All the semesters ?

INDEPENDENT VARIABLE: HSC PERCENTAGE, HSC STREAM, FATHER ANNUAL INCOME

DEPENDENT VARIABLE: RESULT OF ALL SEMESTERS

H0 (Null Hypothesis): Parameters like HSC Percentage, HSC Stream and Father Annual Income are independent (Not Dependent) on Result of all the semesters.

H1 (Alternative Hypothesis): Parameters like HSC Percentage, HSC Stream and Father Annual Income are independent (Not Dependent) on Result of all the semesters. are dependent on Result of all the semesters.

Analysis and Results to prove above hypothesis is as per the following:

Chi-square value analysis for Father Annual Income, HSC Stream, HSC Percentage:

Table 5: Chi-square value analysis for Father Annual Income, HSC Stream, HSC Percentage

| | FAI | HSC PER | STREAM |
|-------------|---------|---------|--------|
| FIRSTSEM | 55.977 | 78.535 | 80.199 |
| SEC O NDSEM | 54.71 | 105.246 | 82.858 |
| THIRDSEM | 58.262 | 96.697 | 85.477 |
| FO URTHSEM | 121.109 | 59.458 | 96.485 |
| FIFTHSEM | 81.376 | 89.726 | 58.668 |
| SIXTHSEM | 120.647 | 91.386 | 93.648 |

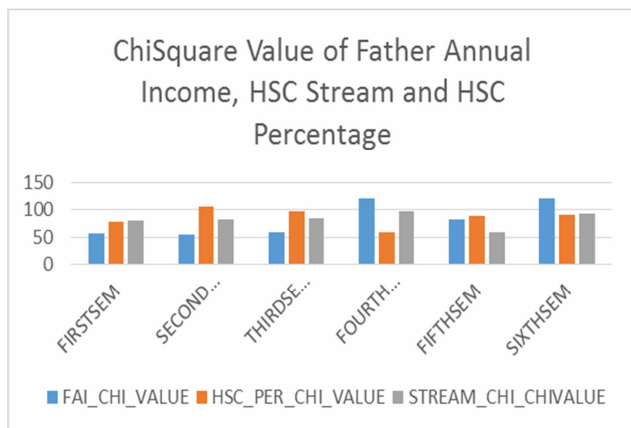


Fig. 3 Bar chart for chi square value of father annual Income, HSC stream and HSC Percentage.

Summary Finding of Chi Square Result Analysis of All the parameters affected on student performance

Table 6: Chi Square Result Analysis of All the parameters affected on student performance

| PARAMETER | CO MBINE CHI_ VALUE | CO MBINE CO RELATION_ VALUE |
|-----------|---------------------|-----------------------------|
| INT_TH | 1530.308 | 0.580 |

| | | |
|------------|----------|--------|
| INT_PR | 855.123 | 0.424 |
| EXT_TH | 1537.369 | 0.563 |
| EXT_PR | 891.288 | 0.464 |
| ASS_M | 290.012 | 0.162 |
| ATT_M | 368.808 | 0.202 |
| FAC_P | 82.232 | 0.090 |
| D_R_H | 271.741 | 0.082 |
| E_W_L_U_H | 233.767 | 0.094 |
| W_L_H | 277.311 | 0.099 |
| W_Li_U | 132.819 | -0.052 |
| FAI | 182.013 | -0.057 |
| HSC_PER | 82.841 | -0.002 |
| HSC_STREAM | 186.889 | 0.072 |

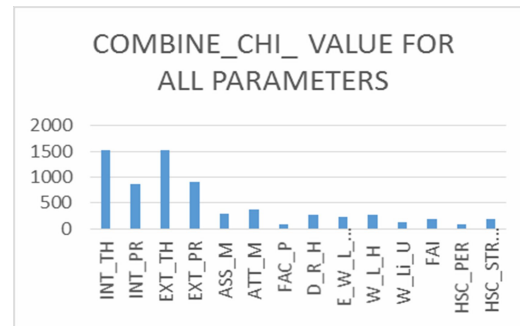


Fig. 4 Combine chi square value of all affected parameters on student performance.

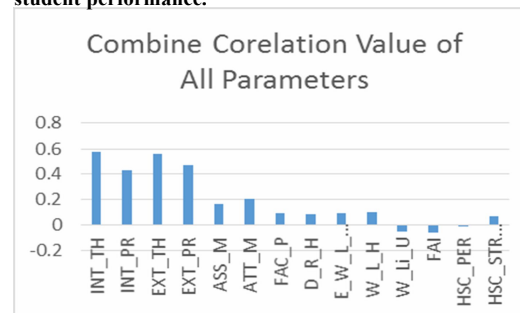


Fig. 5 Combine correlation value of all affected parameters on student performance.

VII. OUTCOME OF ANALYSIS:

By Analysis we have found that Students who have good score in Attendance and Assignment marks can get good score in the examination. Internal Theory and Practical have highest impact on result of examinations. We also found that Internal Marks and External Marks have strong correlation ship so those student who got good score in internal can have chance to get good score in external examination also. Based on statistics result we also prove, Father Income also dependent on student score but correlation shows it is negative co-relationship it means that students whose family income is low or average or middle may get good score but those students whose family income is Very high those students are not too much sincere in study and get low score.

This result also show that there not much impact of library usage on the result of examination.

VIII. CONCLUSION

In this study, we have used 232 attributes with 3558 randomly selected record for the analysis. This 232 attributes have all the demographic and academic records of the students. In this research study we have used SPSS tool and chi square technique for performing analysis on student’s data. In this study student’s data are categorical also chisquare technique is most preferable technique for analysis of the data. We also have prepared some hypothesis for find out the highly affected parameters of student performance. And based on the outcome we conclude that students who are using maximum Computer Lab and Daily Reading Practice can get good score in the examination. Based on analysis we also concluded that students who are good in attendance and assignment can get good score in the examination. Based on the outcome of the analysis, highest affected parameters on student’s results are their internal and external performance in theory and practical head. Based on statistics result we also prove, Father Income also dependent on student score but correlation shows it is negative co-relationship it means that students whose family income is low or average or middle may get good score but those students whose family income is very high those students are not too much sincere in study and get low score. This result also show that there not much impact of library usage on the result of examination. So if we set the parameter

IX. FUTURE SCOPE

This research study aim is only to find the highest affected parameters on the students’ performance based on analysis of student’s demographic information and academic records. But researcher can carry on further research by applying different data mining techniques and can do the prediction, classification, clustering and association on the student data. It will help the decision makers for getting improvement in the performance of students.

APPENDIX

APPENDIX A: LIST OF ABBREVIATION USED IN RESEARCH

| Abbreviation | Description |
|--------------|----------------------------------|
| W_L_H | Weekly Lab hour |
| W_Li_U | Weekly Library Usage |
| D_Re_H | Daily Reading Hour |
| E_W_L_U_H | Extra Weekly Lab Usage hour |
| INT_TH | Internal Theory Marks |
| INT_PR | Internal Practical Marks |
| EXT_TH | External Theory Marks |
| EXT_PR | External Practical Marks |
| SN | Subject Name |
| HT | Hypothesis Testing |
| DF | Degree of Freedom |
| CV | Calculated value of Chi Squared |
| SIG. | Significance value of Chi-Square |
| COV | Corelation Value |
| FAI | Father Annual Income |

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