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Statistical Analysis of Socio-Demographic Factors: Gender, Parental Profession, and Area Status in Shaping Mathematics Achievement

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ABSTRACT
Mathematics plays a vital role in society and serves as the foundation of all creation; without it, life cannot progress. The academic success of students in mathematics can be best evaluated through their performance. Several factors influence students' performance in mathematics, such as gender differences, parents' profession, area status, and departmental differences. This study was designed to examine the mathematics performance of students across these variables, including sex, area status, course of study (departments), and parents' professions. The research was conducted on master's level students from both government and private Universities in Peshawar, Khyber Pakhtunkhwa, Pakistan. Out of 42 Universities in the Province, five were randomly selected, and from these, 300 respondents (201 males and 99 females) were chosen through random sampling. Data were organized and presented in tabular form and analyzed using the Statistical Package for Social Sciences (SPSS) version 30. The findings revealed that independent variables such as gender and department showed a significant difference in students' mathematics performance, whereas area status and parents' professions showed no significant difference.

Keywords: Mathematics Performance, Gender Differences, Socio-Economic Factors, Higher Education, SPSS Analysis

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Introduction

In the Era of 21st century education is considered as a fundamental human right and everyone is entitled to it. It is the first main objective of human activity. Education plays an important role in the development of a country as well as human capital and resources linked with individuals as well, welfare and opportunities for better future (Battle & Lewis, 2002). Furthermore, the educated people of a country will be good citizens and well disciplined. It ensures the Cognitive process of knowledge and skills that enable individuals to increase their quality of life. These increases in productivity also lead towards new sources of income which enhance the economic growth of a country. The most important thing about education is that education not only increases the level of knowledge but also achieving the ability to do something to think and also acquire habits.

EDUCATION SYSTEM

By the system of education, we mean the individual institute which delivers a formal education includes public and private, for profit and non-profit, onsite or virtual instructions and their facilities, students, physical infrastructure, resources and rules and also include the institutes that are directly involved in financing, managing, operating it regulating such institutes (like government and regulatory bodies, central testing organizations, text book brands, and accreditation boards). Finally, in an education system, we include the rules and regulations that guide the individual and institutional interactions within these institutions (Aziz et al…. 2014).

EDUCATION SYSTEM IN PAKISTAN

The education system in Pakistan is divided into six levels. The primary level (from playgroup to 5th grades), middle level (from 6th grades to 8th grades), higher level (9th and 10th, which is leading to the secondary school certificate or SSC); intermediate (eleven and twelve which leading to the higher secondary school certificate or HSC); and Universities level which leading to undergraduate degrees and graduate degrees. The literacy rate ranges in Pakistan from Islamabad is 96% to 28% in the Kohlu District. Literacy rate is different regionally, particularly in sex. In tribal areas the literacy rate of female is only 9.5% which is very low compared to another district of Pakistan.

Pakistan has about 260,903 institutes and facilitating 41,018,384 students with under the supervision of 1,535,461 teachers. The system possessed 180,846 public institutes and 80,057 private institutes.

MATHEMATICS AS A SUBJECT IN NATIONAL CURRICULUM

Education systems worldwide consist of subjects spanning languages, sciences, social sciences, and humanities, all of which enhance critical thinking. Among these, mathematics is considered a core subject due to its applications in diverse fields such as medicine, engineering, electronics, and statistical modeling. Despite its importance, many developing countries, including Pakistan, report weak mathematics performance (Aduda, 2003). Several factors influence mathematics achievement. Studies highlight gender differences, with some (Koller et al., 2001) reporting male students outperforming females in advanced mathematics, while others (Oludipe et al., 2012–13) found no significant difference. Rural–urban disparities are also evident, with rural students underperforming due to poverty, limited resources, and language barriers, whereas urban students benefit from better facilities (Alordiah et al., 2015; Igboegwu & Okonkow, 2012). Additionally, socio-economic status (SES)—defined by education, income, and profession—has been

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shown to affect academic achievement (Barry, 2005; Udida et al., 2012; Eamon, 2005). Prior research indicates inconsistent findings regarding the influence of gender, area status, and SES on mathematics performance, suggesting that these effects vary across contexts and over time. This underscores the need for ongoing studies to verify how these factors impact mathematics achievement.

MATHEMATICS IN OUR SYLLYBUS

In Pakistan, mathematics is placed as a compulsory subject from primary levels to higher levels. In primary levels of Pakistan children learn the mathematical operations, middle level teachers teach their students the algebraic expressions and at higher level the students get the knowledge that how to solve these algebraic expressions (linear equations, quadratic equations etc.) The basic objective of the study is to know the differences of mathematics performance at different levels across Gender, Area, parent's socio-economic status and among different departments.

LITERATURE REVIEW

Onoch (1985) found that children who belong to an educated family have a high socio-economic status (SES) will perform a better performance than a child who belongs to a poor family. The reasons for good performance of educated family's children are good environment for academic work, enough textual academic materials and good feedings.

Friedman, (1989) found that throughout the world, the issue of gender inequality in science, Technology, Mathematics education gives inappropriate results, one meta-analysis covering a period of 1974-1987 on mathematics and led us to two results about gender. The average gender gap is very small (statistically insignificant), and fact that the gap tends to decrease with time.

Hyde et al. (1990) found that, in meta-analysis studies on "gender comparisons of mathematics attitudes and affect", In general, Female students shows a very negative attitude towards mathematics than males, and these attitudes increased with age. They suggest that increase in that's attitude was very problematic because; "if female have more negative attitude towards themselves and learning mathematics, they will learn less mathematics than male as they do" (p. 301).

Young-Loveridge (1992) studied about the attitude of nine-year children about mathematics in Newzeland and he concludes that the nine-year male children like mathematics than the female. Moreover, the boys have a very positive view about the subject the females (74% cf. 46%), and a significantly higher proportion of male performance as being good as the girl did (44% cf. 24%).

Eisenberg et al. 1996 conduct a study on the literature of gender differences in mathematics and suggest that the performance of female students decline up to higher level of studies, but many researchers suggest that the gender differences in mathematics attitudes of America and European students may still maintain.

Edwards (2000), Aremu & Sokan (2003), Asikhya (2010), Akumoluf et al. (2011) they study many factors that affect students' performance like getting knowledge, Teacher qualifications, environment and family status.

Koller et al. (2001) studied the gender differences in mathematics achievements. The study favored the male student's achievements, interest, and placement in advanced mathematics courses.

O'Connor-Petruso et al., (2004) have conclude that the gender differences in mathematics achievements become clearly revealed at the secondary level when female students start to show less confidence in their mathematics ability and perform less than male students

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on solving a mathematical task.

According to the research of Rathman (2004), showed that race, ethnicity or immigrant status are not the important factor with educational achievements. The most relevant factor is the socio-economic factor (SES). According to him he stated these factors as includes parental education levels, neighborhood poverty, parental occupational status and family income. Rathman concludes that, if we do not have housing and neighborhood conditions then he will face significant surmounted in gaining the goal narrowing the achievement gaps. This conclusion clearly shows that socio-economic status is the most important factor in achieving goals.

Abiam and Odok (2006) conduct a study at Nigerian schools on achievements in number, numeration, algebraic process and statistics and found that there is no significant difference in gender and achievements of these performances. However, they found a presence of weak significant association in Geometry and Trigonometry.

According to a meta-analytical finding from 1990s indicated that difference in gender and math performance was trivial in general population by Hyde et al. (2008), d = –0.05, where the effect size, d, is the mean for males minus the mean for females, divided by the pooled within-gender standard deviation.

Asante (2010) observed Collins et al. (2000) citing that symbolically schools create opposition between male and female students through gendering of knowledge and define that several subjects are of males. In distinguishing, female students are established by conditions that mathematics is masculine student's subject, and they satisfied to leave it.

Many attempts have been made to improve students' understanding of mathematics, knowledge in mathematics as well as good perception of mathematics has not resulted in greater achievement in mathematics of Senior High Schools. Students in second year of study still struggle with mathematical concepts and skills. Many students discontinued higher level mathematics studies because of failure in mathematics because of poor understanding, poor knowledge and wrong perception about mathematics (Egodawatte, 2011). Thus, it can be argued that a better understanding in mathematics, knowledge in mathematics and perception of mathematics would help improve the performance of mathematics.

Suleiman et al. (2012) conduct a study on socio economic status of student's parents and found that those students whose socioeconomic status better their academic performance is also strong while those who have bad socioeconomic status have a very poor result in their academic studies.

Zachariah et al., (2012) conduct a study in Kenya, he concludes that the main factors of bad performance of students were gender, socio economic and attitude towards mathematics. He uses a Likert scale to measure the student's attitude towards mathematics and indicate that they have a good attitude towards mathematics.

Rafiq et al. (2013) conduct a study in which he says that parental stress on children is also very effective in the academic performance of students. They examined that parental involvement is very effective in the good academic performance of their children.

Ajai and Imoko., (2015) applied a t-test to know the gender difference in mathematics performance and recalling in Nigeria by using problem-based learning (PBL). The study of Ajai and Imoko conclude that most of the student in Nigeria thought that there did not significantly differ in achievement and retention grades of algebra by using PBL, therefore is evident that male and females' students are capable of competing and cooperate in mathematics

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MATHOD AND PROCEDURE

The purpose of the study is to know the mathematics performance of students at different levels across Sex, Area wise, Course of study (Departments) and their parent's professions wise. This chapter described the population, sampling method, research instruments and participants data analysis and statistics used.

TARGET POPULATION

The descriptive study was conducted using a survey. The population consisted of the students currently studding in BS both males and females are selected. The population of the study consists of all universities in Peshawar. The data were collected through questionnaires from different universities of Peshawar (Government and private).

SAMPLE SIZE OF THE STUDY

A sample of 300 students at all universities was selected through simple random sampling. All the universities of Peshawar were taken as a target population. The number of universities in Peshawar is 42. In these we selected 5 universities randomly which are all of co-education universities. Then we did not know which university has which programs (Medical, Technical, Arts and Management sciences). Firstly, we collect information from these universities about their programs from which 2 universities have all faculties and 3 have missing some programs (Medical programs, technical programs, Arts and Management sciences). In which 2 universities have 17 programs the others have 21, 52 and 19 programs.

INSTRUMENTS

A valid questionnaire was used as research instruments. The researcher has received help from supervisor and made a questionnaire. The questionnaire consisted of twenty three questions including some demographic information. The questionnaire was designed simply so that understood easily. Sample of students consists of 300 students from different universities of Peshawar. The sample consists of 201 male and 99 female respondents from all universities.

DATA COLLECTION

The data were collected through questionnaire. In these 300 questionnaires were distributed in 5 universities of Peshawar in which 201 questionnaires filled by male and 99 were filled by females. The researcher visited each university and contacted students, after seeking permission from authorities, the researcher discusses purpose of the study. The respondents completed questionnaires voluntarily.

DATA ANALYSIS AND STATISTIC USED

To analyze the collected data descriptive and inferential statistics were used. Means were used to show average value of the respondent. 95% confidence interval was used to show the interval of these values. Box plots were also used as a descriptive to show the differences in performance. For model diagnostics the researcher used Box's M test for homogeneity also used p-p plot to check normality. Univariate analysis was also used. Univariate analysis is used to analyze the differences among groups. At the end, researchers used multivariate analysis to analyze the data. MANOVA is the procedure used when there are two or more than two variables for comparing there means.

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ANALYSIS AND INTERPRETATION

The collected data were analyzed by applying MANOVA test by using SPSS (version 30) in which marks percentage of the students are dependent variables and the other factor are independent variables such as Gender, Area status, departments and parents professions. The procedure of analysis is given below.

Level of significance

Level of significance is taken as 0.05

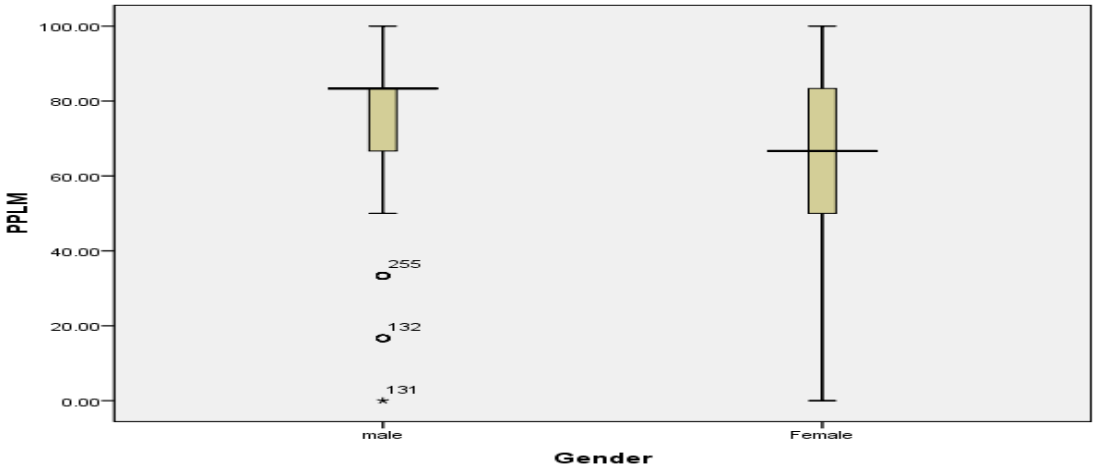
DESCRIPTIVE OF RESPONDANTS AND BOX PLOTS

Table No. 4.1: Primary level results

Gender	N	Mean	95% C.I
Male	201	72	69, 75
Female	99	62	57, 66

Figure 1, Box plot for gender at primary level

From table 4.1, we see that the performance of male students is better than the performance



of male students in mathematics at primary level. Also in Figure 1, we see that there is significant difference between the performance of male and female students (Sex) at primary level in mathematics.

Table No. 4.2: Middle level results

Gender	N	Mean	95% C.I
Male	201	56	52, 59
Female	99	48	43, 52

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Figure 2, box plot for gender at middle level

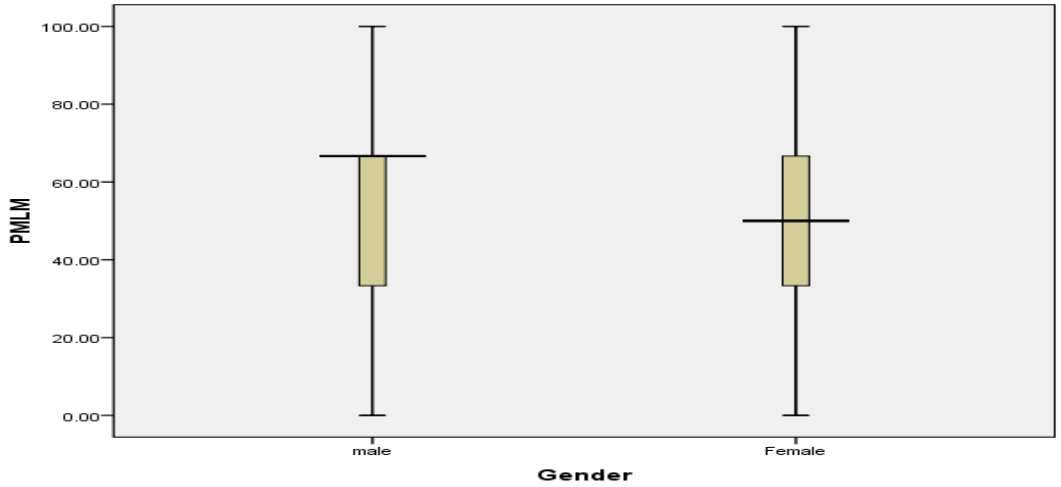

Table 4.2, also gives us the result that the performance of male is good in mathematics at middle level compare to female students. Figure 2, shows that there is significant difference in mathematics performance at middle level and gender wise.

Table No. 4.3: Higher level results

Gender	**N**	**Mean**	**95% C.I**
Male	201	46	43, 50
Female	99	40	35, 45

Figure 3, box plot for gender at higher level

Table 4.3 shows the result for higher level marks which shows that the average marks of male students is higher than female students which means that the performance of male students is good than the performance of female at higher level. Also figure 3 shows us that there is significant difference between gender and mathematics performance. Overall result shows us that the performance of male students is good compared to the female students at every level of the studies and also, we found that the female performance is decreasing at higher level. The box plots shows that there is significant difference between performances of students at different levels in mathematics.

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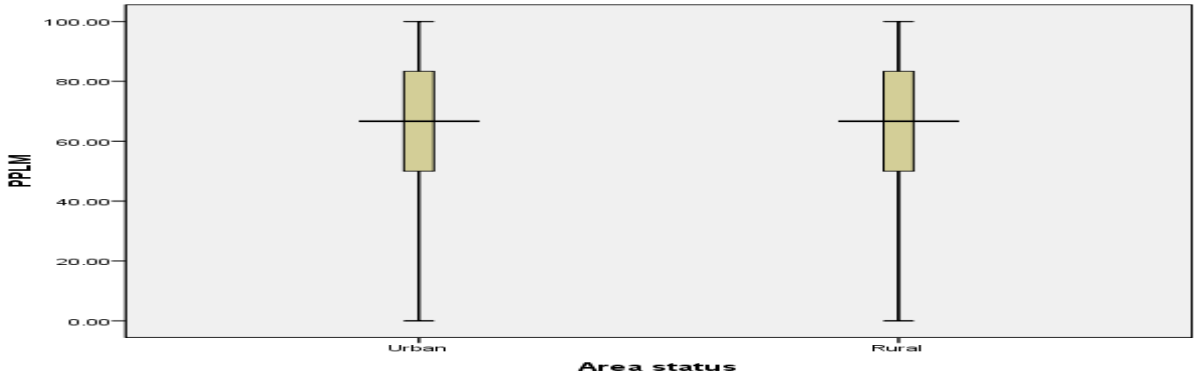
Table No.4.4: Primary level results for area status

Area status	Number of students	Mean	95% C. I
Urban	168	67	63, 71
Rural	132	71	67, 75

Figure 4, Box plot at primary level for area status



In Table 4.4, the performance of rural area students is better than the performance of urban area students in mathematics but figure 4 shows us that there is no such a difference in the performance of students in mathematics at primary level.

Table No. 4.5: Middle level results for area status

Area status	Number of students	Mean	95% C.I
Urban	168	52	48, 55
Rural	132	55	51, 59

Figure 5, Box plot for area status at middle level|

Table 4.5 shows that the performance of rural area students is a little bit good but the figure 5 shows that there is no such difference in performance of students at middle level in mathematics area wise.

Table No. 4.6: Higher level results for area status

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Area status	Number of students	Mean	95% C.I
Urban	168	45	41, 49
Rural	132	44	39, 48

Figure 6, Box plot for area status at higher level

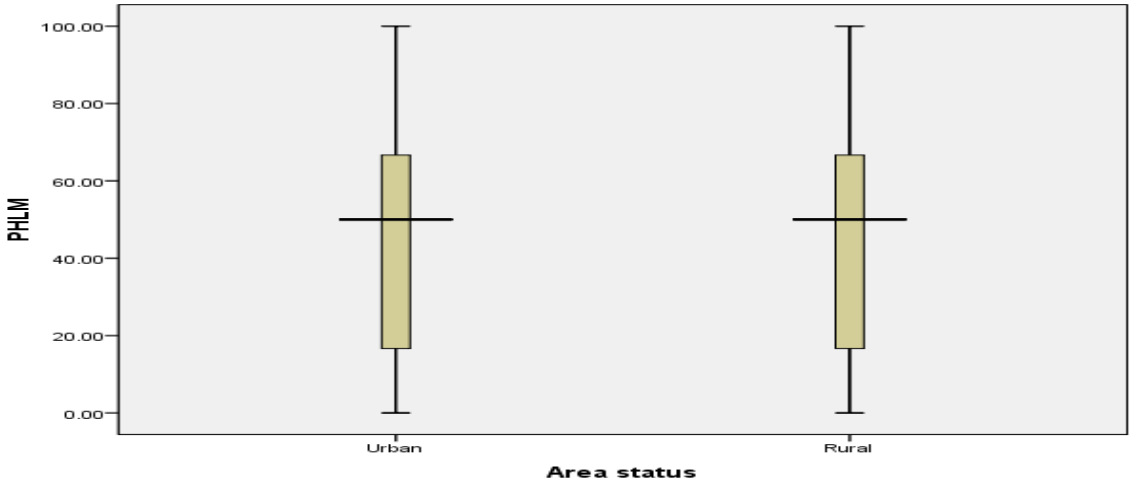

Table 4.6 shows that the performance of students at higher level is almost same, figure 6 also shows that there is insignificant difference between urban and rural students.
Since we conclude that there is insignificant difference between urban and rural students at different levels in mathematics.

Table No. 4.7: Primary level results for departments

Departments	No of students	Mean	95% C.I
Languages	37	36	30, 41
Medical fields	36	53	49, 58
Management sciences	74	33	28, 37
Technical fields	153	59	55, 63

In Table 4.7 Languages include English, Urdu, Pashto and Arabic etc while Medical fields (zoology, Botany, Chemistry etc.), Management sciences include BBA, MBA, LLB etc and Technical fields includes Mathematics, statistics, Physics and electronics etc.

Figure 7, Box plot for department at primary level

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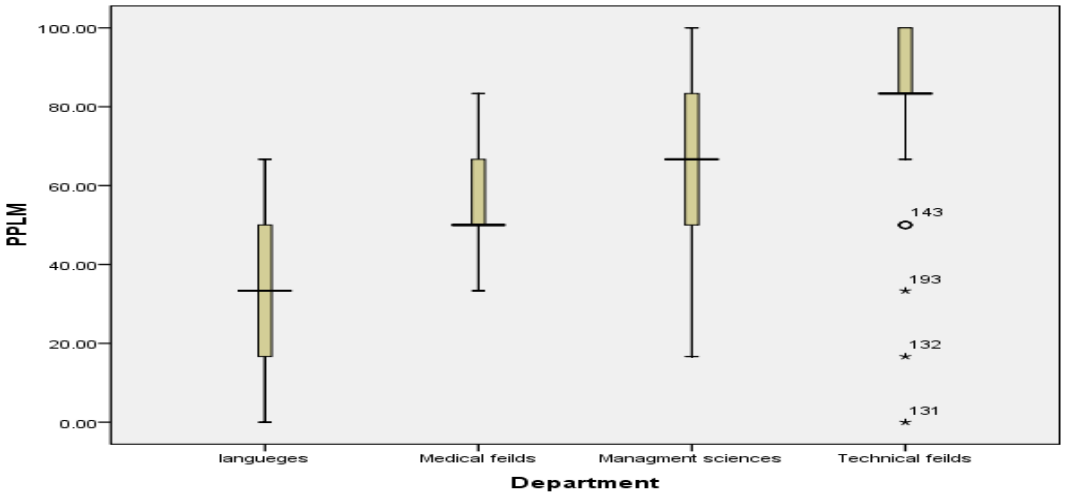

In table 4.7 we see that the performance of technical field and medical fields is better than the other departments while in figure 7 we see that there is significant difference between different departments at primary level.

Table No. 4.8: Middle level results for departments

Departments	No of students	Mean	95% C.I
Languages	37	31	25, 38
Medical fields	36	43	38, 49
Management sciences	74	44	39, 49
Technical fields	153	65	61, 68

Figure 8, Box plot for departments at middle level

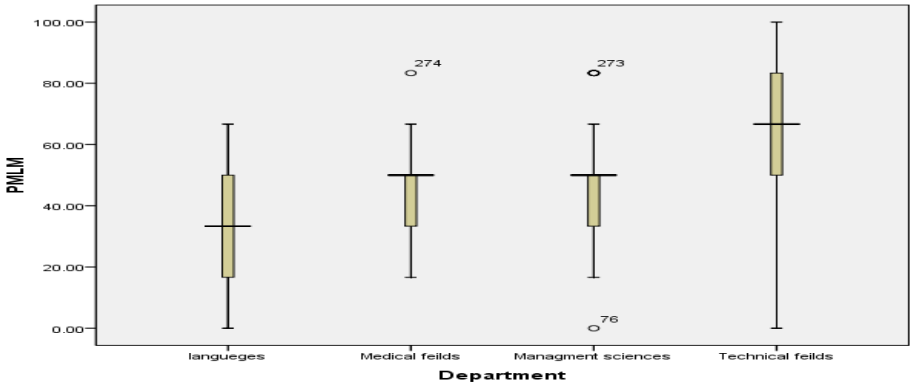

Table No. 4.9: Higher level results for departments

Departments	No of students	Mean	95% C.I
Languages	37	25	20, 30
Medical fields	36	27	20, 33
Management sciences	74	33	28, 37
Technical fields	153	59	55, 63

Figure 9, Box plot for department at higher level

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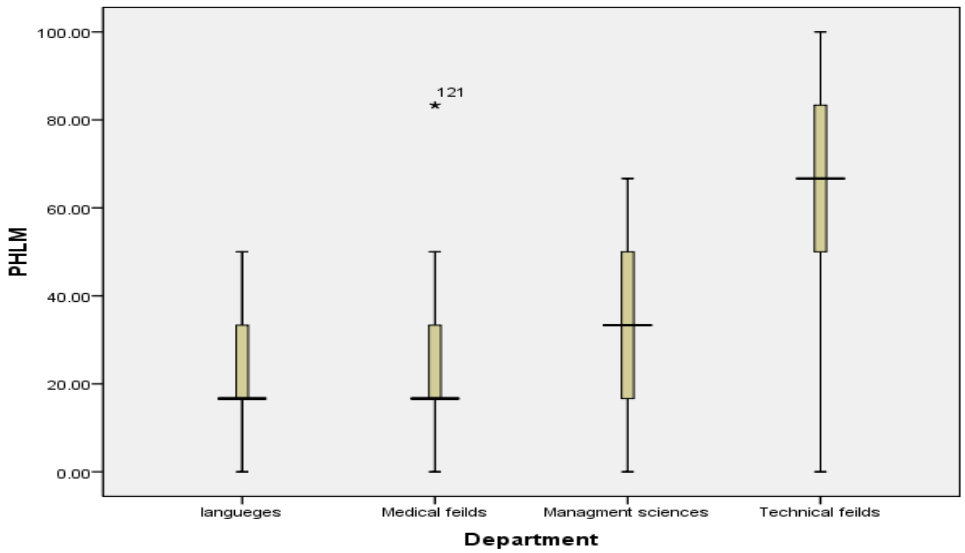

Table 4.8 and 4.9 shows that the performance of technical fields students is better at both middle and higher levels compared to other departments while figure 8 and 9 shows that there is significant difference between departments at different levels in mathematics performance.

Table No. 4.10: Primary level results for parents' professions

Parents professions	No of students	Mean	95% C. I
Technical fields	27	65	56, 74
Educational departments	47	70	63, 78
Political/ Business	68	67	61, 73
Forces	27	71	63, 79
Others	131	69	64, 73

Technical fields (Doctors, Engineer and Technical people)
Educational departments (Teachers, professor etc), Political/ Business (Ministers, Businessmen, bankers etc), Forces (Army, police, security etc), Others (Govt. servant, late, none etc)

Figure 10, Box plot for parent's professions at primary level

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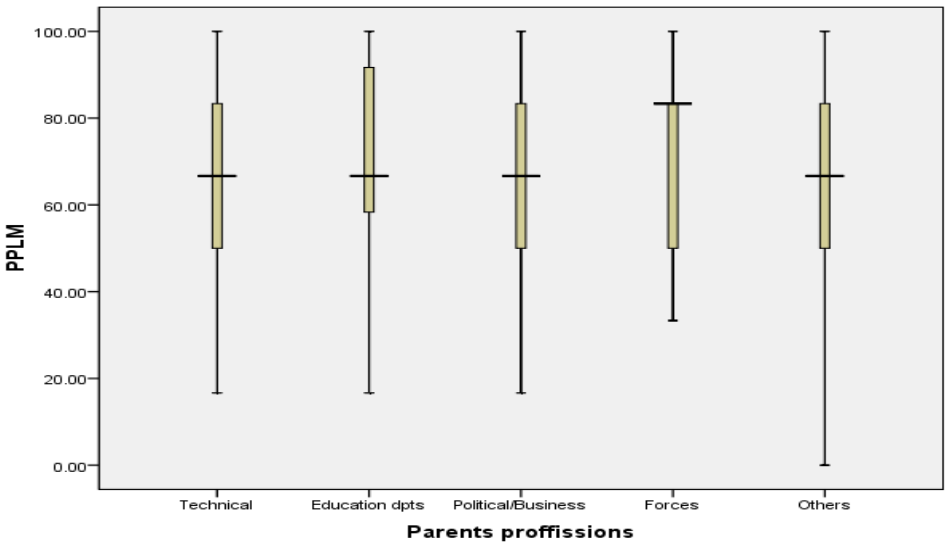
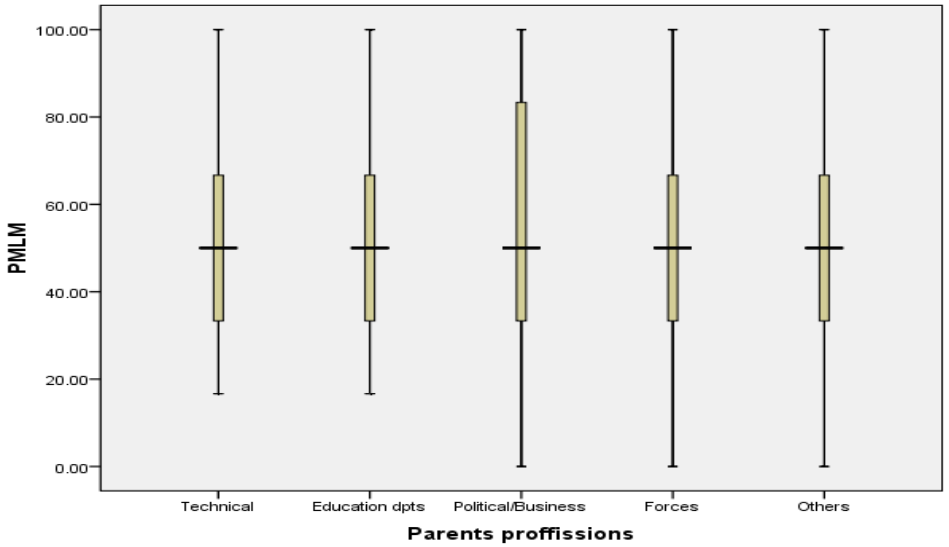


Table 4.10 shows that the performance of students is almost same at primary levels of their parent's professions, and the box plot also shows that there is insignificant difference in their parent's professions at primary level in the performance of mathematics.

Table No. 4.11: Middle level results for parent's professions

Parents professions	No of students	Mean	95% C.I
Technical fields	27	53	44, 62
Educational departments	47	52	44, 60
Political/ Business	68	56	50, 61
Forces	27	52	41, 63
Others	131	52	48, 56

Figure 11, Box plot for parent's professions at middle level



The table 4.11 shows that there is no difference in the performance of students according

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to their parent's professions and figure 11 shows that there is insignificant difference between parent's professions of students.

Table No. 4.12: Higher level results for parent's professions

Parents professions	No of students	Mean	95% C.I
Technical fields	27	43	32, 53
Educational departments	47	45	37, 53
Political/ Business	68	46	40, 52
Forces	27	41	30, 51
Others	131	44	40, 49

Figure 12, Box plot for parent's professions at higher level

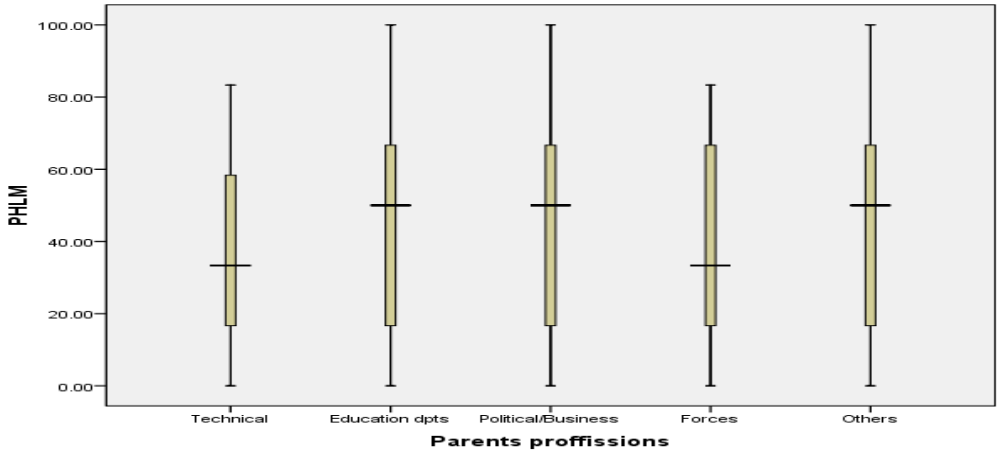

Table 4.12 gives us the result that the performance of students is almost same at higher level but figure shows that there is a little difference in those students whose parents are at technical department and forces, but no such difference found.

MODEL DIAGNOSTIC

First the equality of covariance matrices was tested with Box M test equality of covariance matrix of the group (sex, area status, departments and parents' professions) under study. The hypothesis for Box M test is stated as.

Gender: H_0: $\sum_m=\sum_f$ vs H1: $\sum_m\neq\sum_f$.

Area status: H_0: $\sum_u=\sum_r$ vs H_1: $\sum_u\neq\sum_r$

Departments: H_0: $\sum_l=\sum_m=\sum_{ms}=\sum_t$ vs H_1: At least one sigma's is different.

Parent's professions: H_0: $\sum_t=\sum_e=\sum_p=\sum_f=\sum_o$ vs H_1: At least one sigma's is different.

Table No. 4.13: Test for equality of covariance matrices

Variables	Box's M	F-values	df1	df2	p-values
Gender	4.713	.775	6	2.525E5	.589
Area status	7.722	1.273	6	5.545E5	.266
Department	34.353	1.857	18	6.568E4	.015

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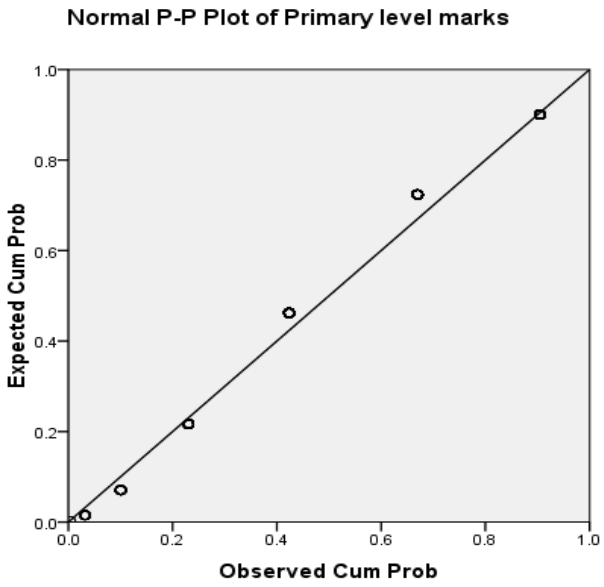
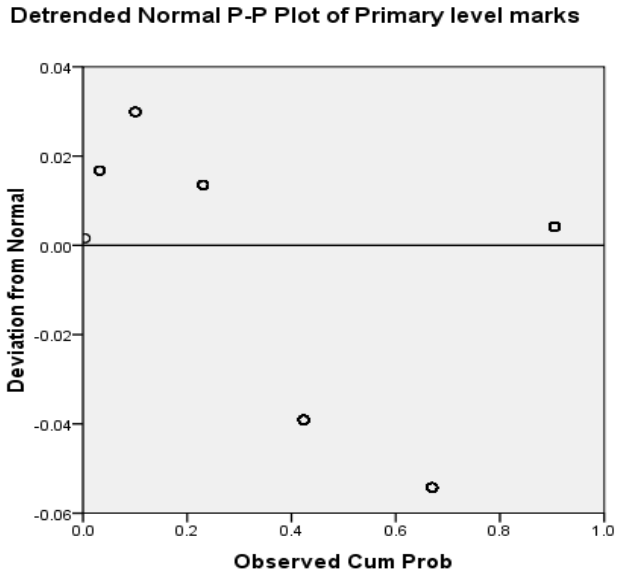
Parents professions	24.404	.984	24	4.972E4	.484

From table 4.13, we see that the p-values are greater than (α) level of 5% across the variables. Therefore, we reject our null hypothesis which is no difference and conclude that, all the covariance matrices are equal among the variables.

Figure 13: Diagnostic plots of performance indicator





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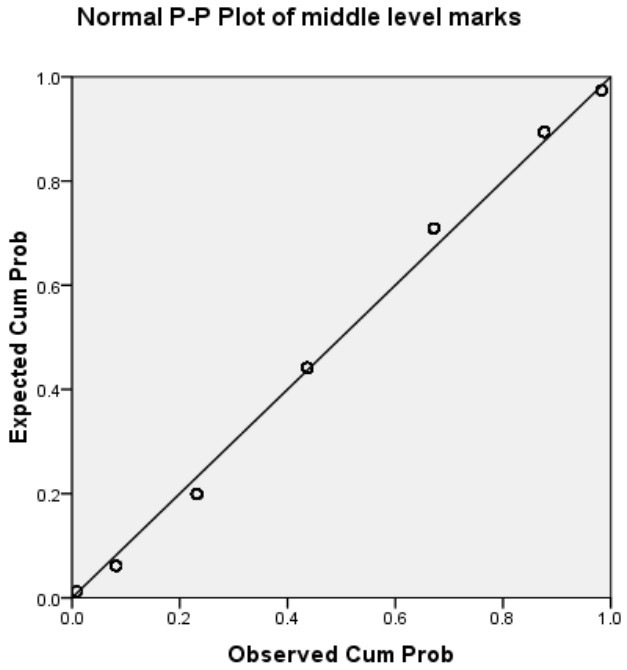

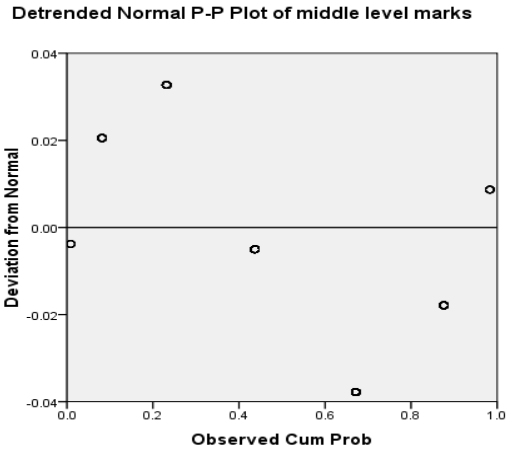

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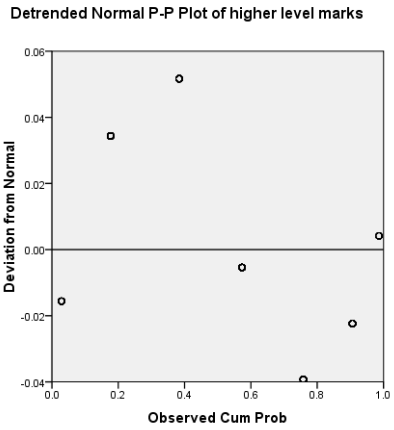


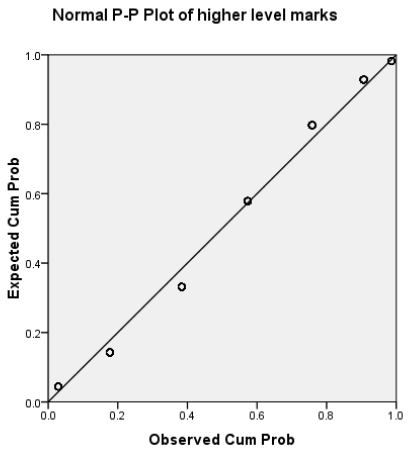
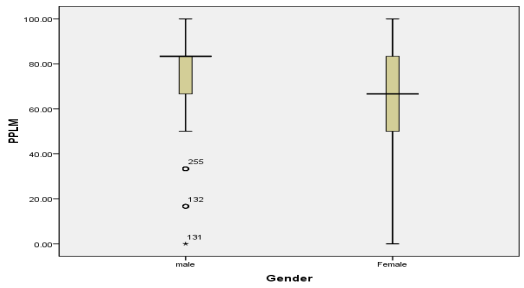


Figure 13 represents the diagnostic plots of residuals of the performance indicator. It shown clearly that the residuals are normally distributed Also, the residuals plots and the predicted values indicate that the residuals are random.

Table No. 4.14: Uni variate result for primary level

The table 4.14 shows that there is significant difference between sex and departments but insignificant difference in area status and parent's professions at primary level at 95% of significant level.

Figure 14, Box plots for primary level



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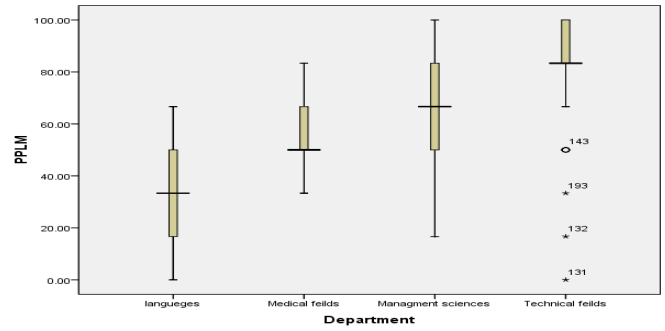

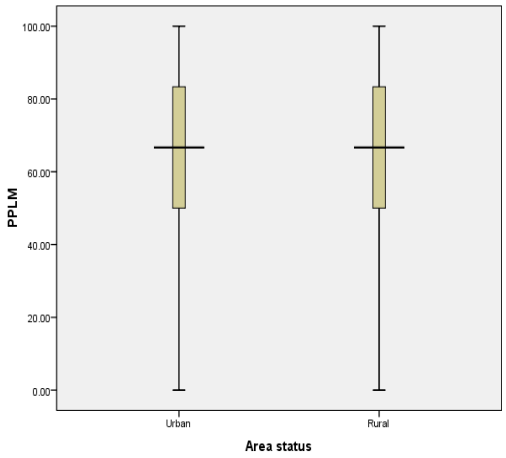

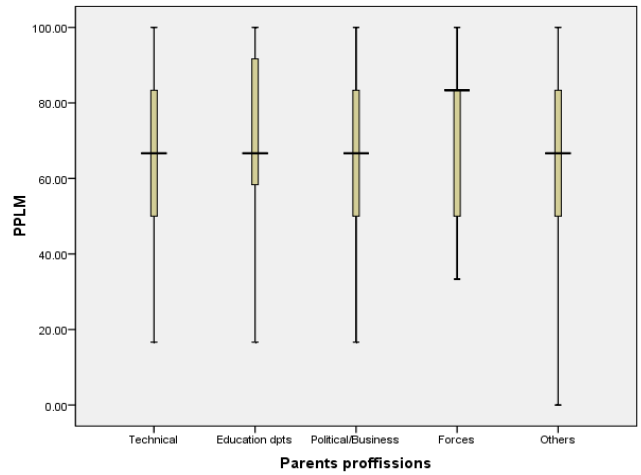

The figure shows differences in sex wise and departments wise while area status and their parent's professions have no such differences seem.

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Table No. 4.15: Univariate result for middle level

Source	Type I Sum of Squares	Df	Mean Square	F	Sig.
Model	907306.079[a]	10	90730.608	215.918	.000
Gender	862907.223	2	431453.612	1.027E3	.000
Area	595.652	1	595.652	1.418	.235
Department	43123.964	3	14374.655	34.208	.000
Parents	679.240	4	169.810	.404	.806
Error	121860.588	290	420.209		
Total	1029166.667	300			

a. R Squared = .882 (Adjusted R Squared = .878)

Figure 15, Box plots for middle level

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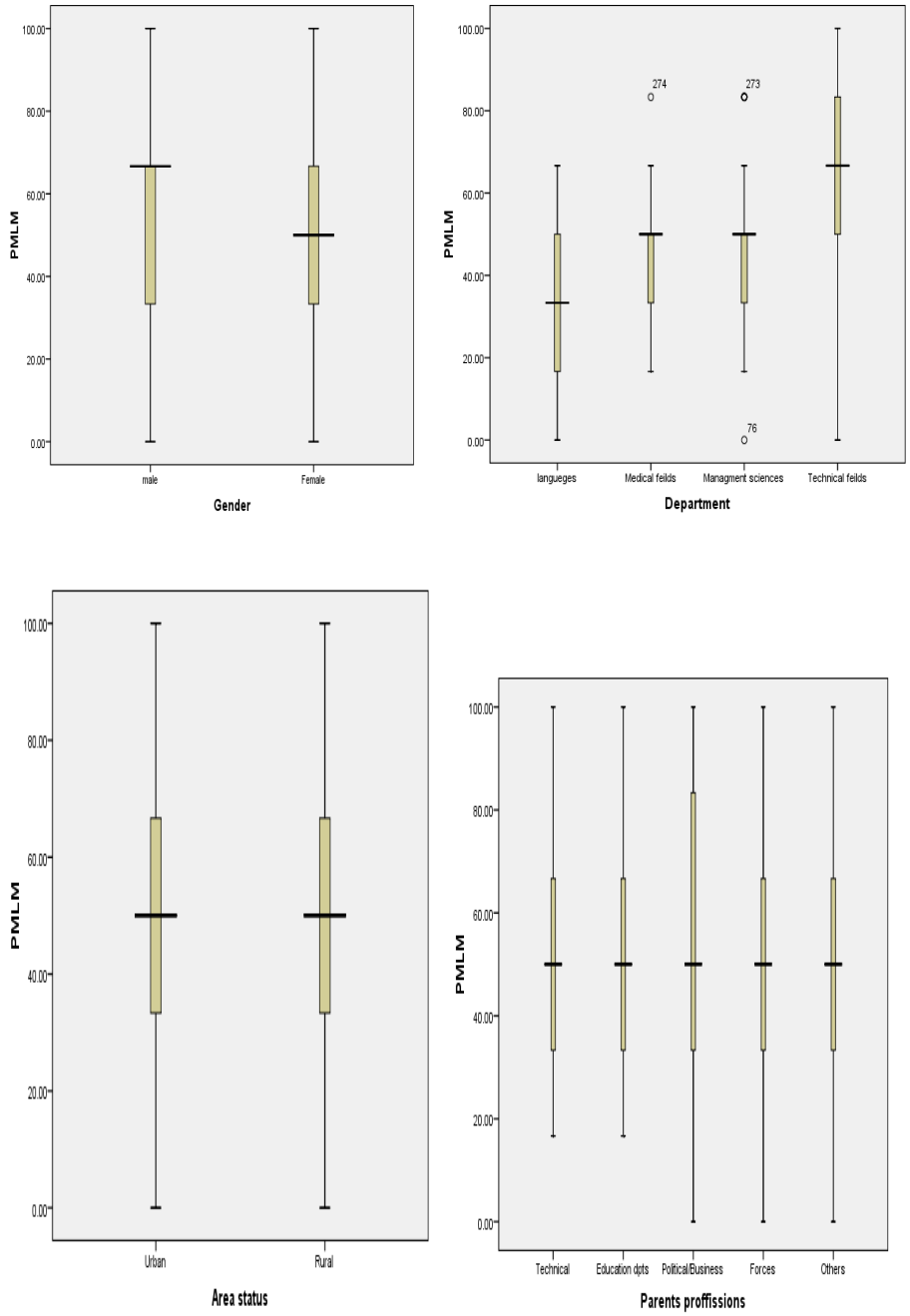

In figure 15, it has seemed that there is no difference in mathematics performance of students Area wise and their parent's professions while a difference seem in Gender wise and departments wise at middle level.

Figure 16, Box plot for higher level

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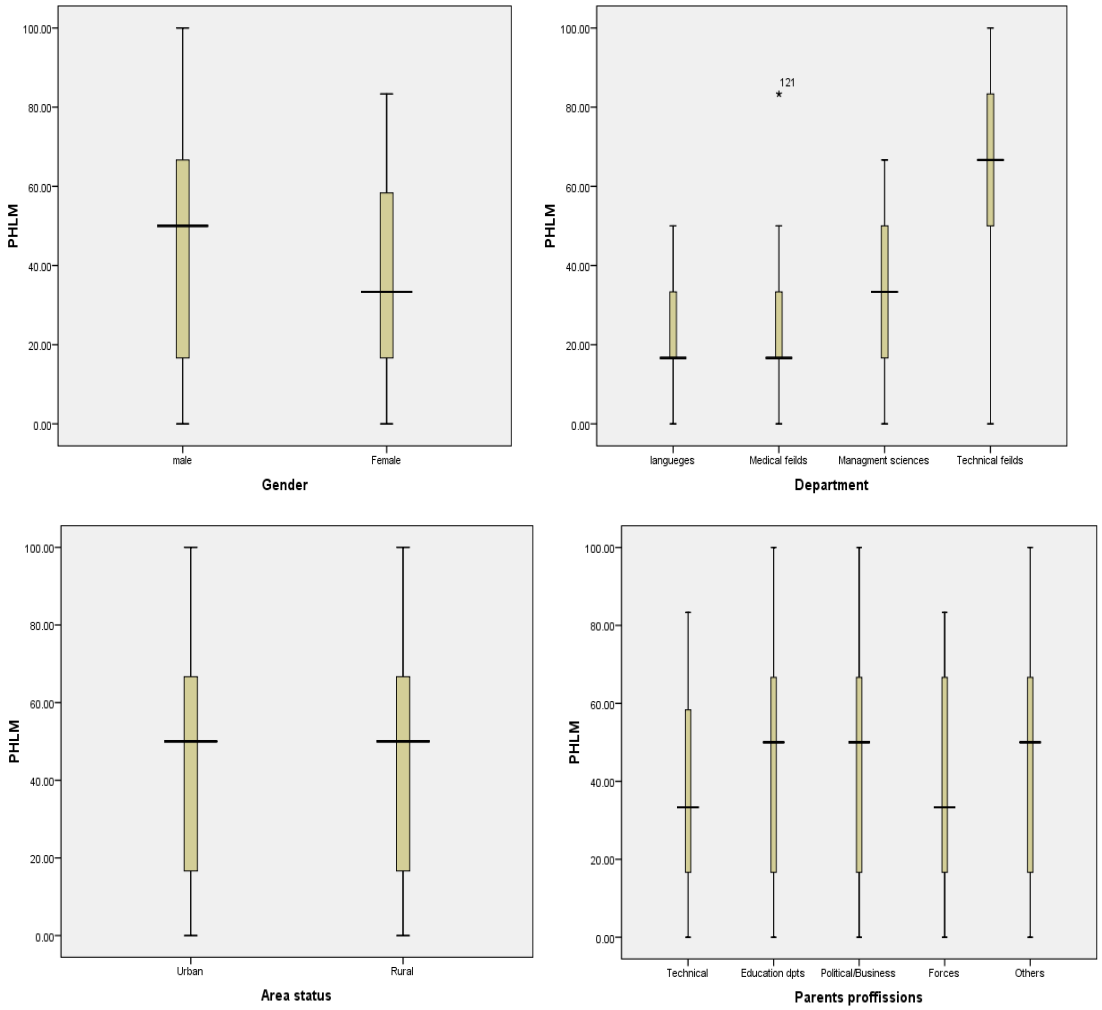

In Figure 16, it is clear that there is significant difference in Gender and departments while no such a difference is found in Area status and their parent's professions.

Multivariate analysis

Table 4.5.1 Multivariate analysis

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Effect		Value	F	Hypothesis df	Error df	Sig.
Gender	Pillai's Trace	.949	87.005	6.000	578.000	.000
	Wilks' Lambda	.051	3.296E2[a]	6.000	576.000	.000
	Hotelling's Trace	18.650	892.095	6.000	574.000	.000
	Roy's Largest Root	18.650	1.797E3[b]	3.000	289.000	.000
Area	Pillai's Trace	.020	1.914[a]	3.000	288.000	.127
	Wilks' Lambda	.980	1.914[a]	3.000	288.000	.127
	Hotelling's Trace	.020	1.914[a]	3.000	288.000	.127
	Roy's Largest Root	.020	1.914[a]	3.000	288.000	.127
Department	Pillai's Trace	.566	22.486	9.000	870.000	.000
	Wilks' Lambda	.462	29.095	9.000	701.067	.000
	Hotelling's Trace	1.105	35.181	9.000	860.000	.000
	Roy's Largest Root	1.048	1.013E2[b]	3.000	290.000	.000
Parents	Pillai's Trace	.032	.791	12.000	870.000	.660
	Wilks' Lambda	.968	.791	12.000	762.268	.660
	Hotelling's Trace	.033	.791	12.000	860.000	.660
	Roy's Largest Root	.027	1.979[b]	4.000	290.000	.098

Exact statistic

The statistic is an upper bound on F that yields a lower bound on the significance level.

Design: Gender + Area + Department + Parents

Table 4.5.1 shows us that the p-values of Gender and departments are less than the $\alpha=0.05$ which we conclude that there is significant difference at 5% level while the p-values of area status and their parent's professions are greater than $\alpha=0.05$ so we conclude that there is insignificant difference. At the end we can say that there is an association in the performance of mathematics and gender also there is association in department wise but there is no relation with area status and student's parent's professions with the performance of mathematics.

CONCLUSION

The performance of students in mathematics depends on various factors. Some of the factors belong to environment and some are outside the environment (outside institute). The factors which affect the performance of students which we studied are sex, Area status, departments and their parent's professions. It is concluded that the variables such as area status and their parent's professions are insignificant and the other variables such as gender and departments are significant with student's performance of mathematics.

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