

Exploring the Impact of Mathematics Perception on Students' Performance

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Abstract:

The aim of this study is to analyze students' attitude and interest in Mathematical courses. Additionally, students' perception on teaching methodology adopted by the teachers is also analyzed in this study. This study investigated a relationship between students' perception and their Mathematics results. There were 330 students selected using random sampling, from different departments who were taking Mathematics course in fall 2017 at Sukkur IBA University. A survey was conducted through questionnaire and data were collected. Using inferential statistics (Pearson correlation, One-way ANOVA test and Independent t-test), data analysis was performed through statistical package (SPSS) version 19.0. The results specify that the level on students' perception towards Mathematics subject is good among all departments and there is a negative non-linear relationship between students' perception and their Mathematics courses results. Furthermore, it was concluded that male and female contain good and same level of perception about the subject.

Keywords: *Mathematics Performance; Statistical Analysis; Students' Perception; Fear of Mathematics*

1. Introduction

Some factors are considered important in learning process of a subject at educational institutes. They can highly influence students' performance in the subject positively or negatively. The factors that can affect students' performance can be their interest and attitude towards the subject, their learning strategies towards the subject, teacher's teaching methodology and so on. So, the student's performance in the subject depends on student's perception about the subject. Different subjects are being taught at Sukkur IBA University, Mathematics is one of them. It is applicable to many educational fields for example Engineering, Business, Computer Science. The subject of Mathematics needs thinking and logical reasoning while solving different problems. Most of the times it is being heard that Mathematics is a difficult subject, and some reply it as that nothing is difficult, it is all about our perception.

According to the study [1], one's attitude towards a subject plays a key role in the subject understanding. Attitude is an expression of showing favorableness or un-favorableness

towards any object whether it is a person or a thing. Attitude in a person can be developed from a persons' past or present experiences and that results in positive attitude or negative attitude.

Interest is the emotional level that causes a person to be attentive towards an object that is when object attraction becomes high, an interest is developed towards that object. In study [4], It has been analyzed that performance in mathematics is highly influenced by one's interest towards the subject. A student's efforts and enthusiasm in learning a subject show their level of interest towards the subject.

Teaching methods of a teacher shows a teachers' ability of teaching a subject. So, teaching methodology of a teacher's is a crucial factor in the perception model to determine students' achievement in a subject [7]. It is very important to know that what teaching methods and strategies a teacher is applying during the teaching process. The study [8], believes that throughout the teaching process, a teacher's appearance, teaching strategies and his/her style of declaring the lecture can have a high influence on students' understanding towards the

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subject. The teacher should make some efforts to provide the effective material to students and other teaching aids for example providing help after lecture scheduled times, in order to make learning process easy for them.

In this paper, in Section II Literature review is provided. Problem Definition is stated explicitly in Section III. section IV consists of Methodology for solving the Problem, section V discusses the results and finally Conclusion and Future Directions are explained in section VI.

2. Literature Review

Positive or negative perception of a student in a subject can highly impact students' performance. Perception of a student can be measured by many factors like attitude, interest, motives, cognitive structure, expectations, teachers' teaching methodology and so on. This study intends to find the relation between students' perception and students' perception about subject. Three factors are considered for this study, they are attitude, interest and teachers' teaching methodology. A person with a positive attitude can learn the subject in a better way as compared to a person with negative attitude. So, this negative attitude during the subject learning needs to be changed to achieve satisfactory results, [2]. The mathematics subject needs a lot of thinking and it is impossible with a negative attitude. According to [3], only positive attitude can make a student think in a creative style and to be active in learning process. The study further states that positive attitude can motivate student to participate in the group study and discussions which can have beneficial effect on his/her communication skills.

Along with positive attitude, student should also develop some interest towards the subject. Study [5] analyzed the difference between general interest in Mathematics and an interest to participate in the Mathematical activities, students with the latter are beyond the level of simple calculations and algorithms. The study [6] found that high interest towards a subject can increase the students' performance level in a subject and students will want to understand the subject in depth.

There is a significant role of teacher or his/her teaching style in developing the interest and positive attitude among students towards the subject. The study in [9], analyzed that if a student's perception about the subject teacher is not good because of his/her teaching methodology, then it will cause a negative attitude towards the subject. There should be good communication and cooperation among students and teacher during learning process.

The inferences from the study [11] showed that students' perception can have significant impact on students' performance in Mathematics subject. According to the study

[12], some myths about the mathematics are widespread among students can cause the students' negative perception towards the subject, which leads to the poor student performance in class and poor mathematics results. The study [15] provides an overview of past research that has investigated the association between math anxiety and math achievement, factors that can cause math anxiety, characteristics of students that can increase their susceptibility to math anxiety, and efforts that educators can take to remedy math anxiety. A study presented in [16] analyzed that teachers' role influenced students' interest and their mathematics achievement. The teacher's role as a motivator was factored as the delivery of learning goal and learning comfort and the author came up with some effective results.

3. Problem Identification

As stated earlier, Mathematics is one of the challenging subjects and considered difficult among students of each level and they believe that Mathematics is just for talented and extraordinary students. This assumption and bad perception cause lack of confidence and thus affects students' results. So, the study aims to investigate whether students' perception effect on their Mathematics performance.

Sukkur IBA University, a public-sector university in Pakistan, offers different Mathematical courses to engineering, business and computer science students. During previous years, a high failure rate and low scores/GPA in Mathematics related courses has been observed in each department. It can be further illustrated from the students' performance chart given below:

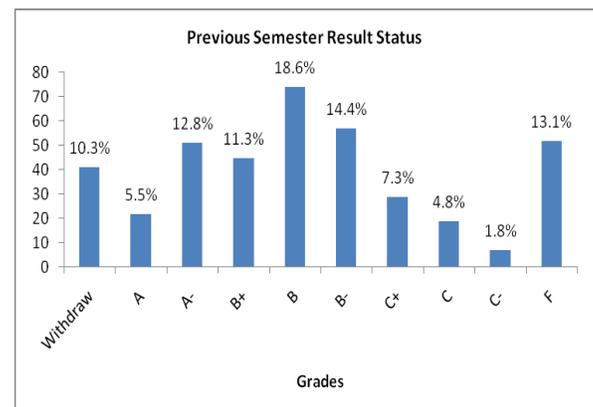


Figure 1: Previous Semester Result Status

From figure it can be observed that 13.1% failed the subject and 10.3% withdrew from final exam. 44% students passed the

subject in B category, only 18.4% students passed the subject in A category and nearly 14% students passed in C grade category. Hence students with good grades are less.

To achieve the cause behind this high failure rate and low grades, the study aims to explore the perception of students regarding the teaching methods of their Mathematics lecturer, their attitude and interest towards Mathematics subject.

4. Methodology

4.1. Hypothesis of the Problem

The main objective of the study is to investigate whether the students' perception about the subject effects on students' performance in Mathematics. Whereas four hypotheses are derived to investigate the study based on research question. Because data should be tested in every perspective before stating any results.

- Hypothesis-1: Whether there is any difference in students' level of perception among all departments?
- Hypothesis-2: Analyzing the Perception level of both gender categories i.e. male and female.
- Hypothesis-3: Is there any positive or negative relation between gender discrimination and students' performance in Mathematics subject.
- Hypothesis-4: Examining the relationship of students' perception among all departments with their performance in Mathematics subject.

4.2. Data Collection

The data was collected through a questionnaire from undergraduate students of Business Administration Department (BBA), Department of Computer Science (BCS) and Electrical Engineering Department of Sukkur IBA University during their fall semester 2017. The purpose of this analytical study is to describe the level of students' perception towards Mathematics.

4.3. Perception Model

The concept of the study is taken from a previous study [4] that is done recently [4]. Fig 2. represents the model of Students' perception towards Mathematics. According to the model, student's Interest and Attitude and Teacher's teaching ability play an important role in the Mathematics performance of student.

There are many components which can be included in students' perception towards Mathematics as specified by [12] which has presented a Mathematical Perceptions development model.

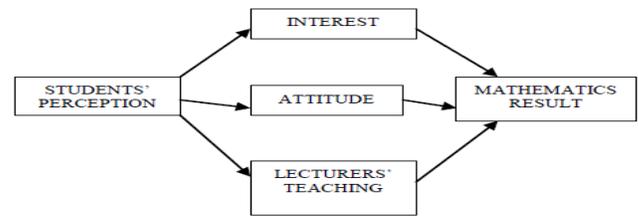


Figure 2. Perception Model for Students Towards Mathematics

4.4. Data Sampling Procedure

The target population for this study consists of undergraduate students of Sukkur IBA University. A sample of three hundred and three (303) students was taken from the target population. The undergraduate students of the three-targeted departments of the institute which offers Mathematical courses in fall semester 2017. Sampling procedure for this study consists of two stage sampling, stratified sampling and Simple random sampling technique.

• **Stratified Sampling:** In first step Stratified sampling was performed. The stratification covered three departments of the Institute which are Business Administration (BBA), Computer Science (BCS) and Engineering (BEE). The final year students are not included in these strata as they didn't have any Mathematics Course in fall semester 2017.

• **Simple Random Sampling:** After doing stratification, in second step, students were randomly selected from each stratum through simple random sampling technique. There were 330 students from which 190 students from BBA department, 60 from BEE department and 80 from BCS department were included in the sample.

• **Sample Size:** Eight hundred (800) students were enrolled in Business Administration (BBA), Computer Science (BCS) and Engineering (BEE) departments. The sample size was calculated using sampling calculator available at this [14] website. So, a sample size of 330 is obtained using population size of 800 with 95% Confidence level.

4.5. Research Instrument

Data collection was performed through a questionnaire based on 4-point Likert scale. Data collected was of qualitative type and then was converted into quantitative data. One part of the questionnaire consists of some demographic information such as field and year of the study whereas other one included 30 questions based on three domains that is 11 for Attitude Domain, 8 for Interest Domain and 11 for students' perception

on teachers' teaching methodology. In questionnaire, 1-19 items were based on endorsement scale rated as strongly agree (4), agree (3), disagree (2), strongly disagree (1) and reverse was considered for negative items and for remaining 10 items, 20- 30 items were based on frequency scale rated as Always (4), Often (3), Rarely (2), Never (1) and reverse scale was considered for negative items.

The reliability index of the instrument was determined by the Cronbarch Alpha test. The Alpha value for the instrument is 0.81 which is a satisfiable value and shows the consistency and reliability of items in the instrument [13]. Also, the Alpha values of each domain was described which are satisfiable values and given in the Table I.

Table I. Distribution of Items based on Domain

Domain	No. of Items	Alpha Values, α
ATTITUDE	3,5,6,8,9,10,11,24, 25,26,27	0.81
INTEREST	1,2,4,7,20,21,22,23	0.85
TEACHERS' TEACHING	12,13,14,15,16,17, 18,19,28,29,30	0.52

4.6. Mathematics Result

Students' performance indicator for Mathematics was taken as their Mathematics scores (out of 100) based on results of fall 2017. The score of failed students was zero 0. Students' Mathematics result was gathered from academic records in the University.

5. Data Analysis

5.1. Data Preprocessing

The collected data from the research instrument was first preprocessed that is, non-serious responses of students and missing answers were removed. The remaining 318 responses out of 330 were then, measured for further data analysis.

5.2. Questionnaire Visualization

The figures given below are giving a complete visualization of questions with students' responses that are used in survey to collect the data. Figure 3a and 3b are representing the students' attitude and interest towards Mathematics Subject. Figure 4a and 4b are visualizing perception of students about teachers' teaching methodology.

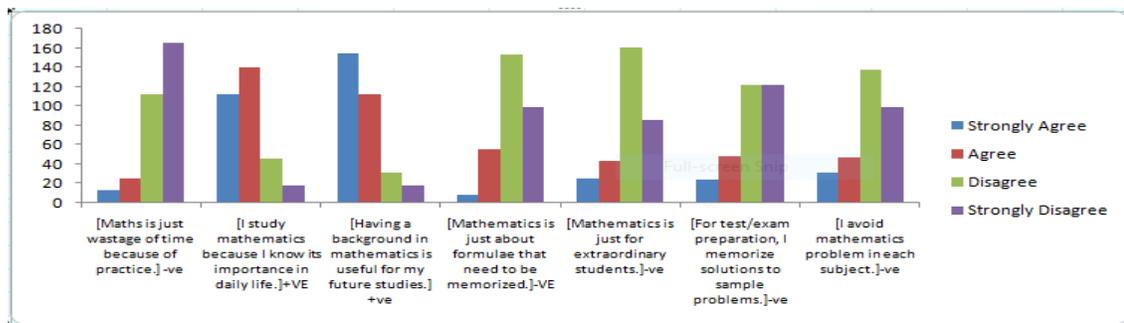


Figure 3a. Students' response showing attitude and interest

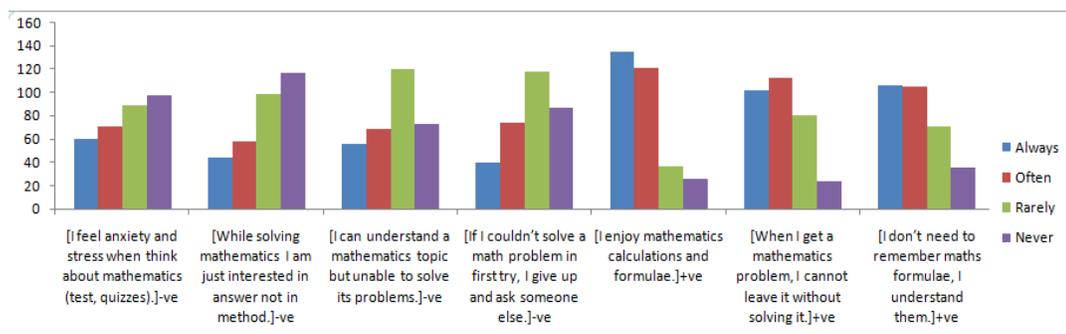


Figure 3b. Students' response showing attitude and interest

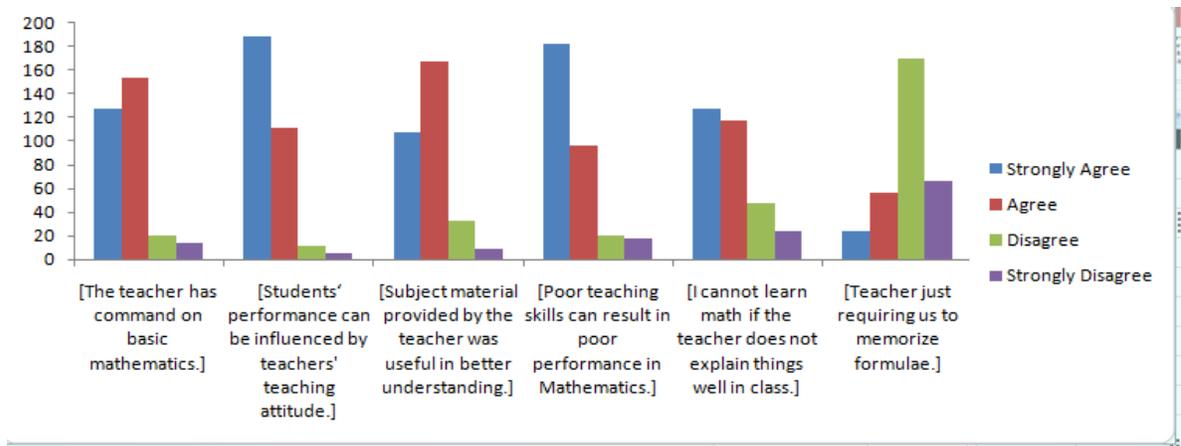


Figure 4a. Students' response representing Teachers' teaching ability according to students

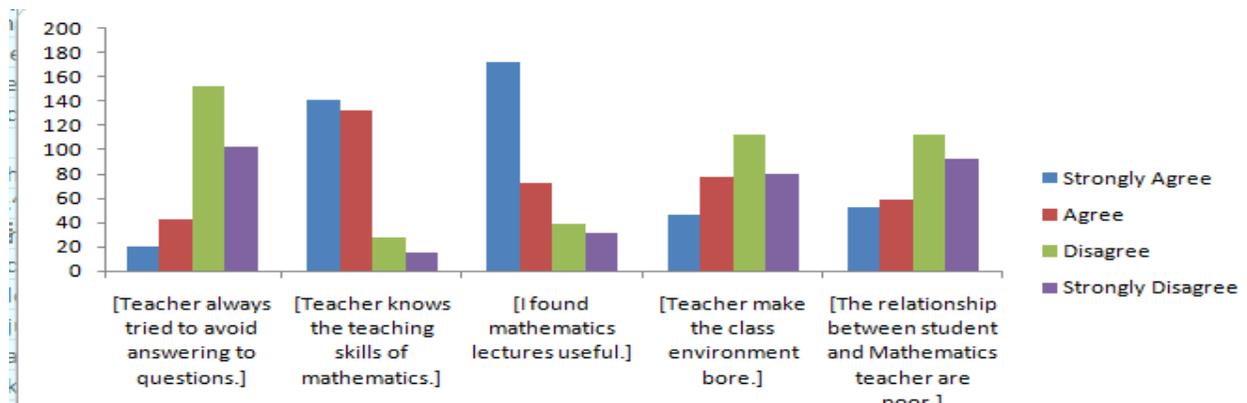


Figure 4b. Students' response representing Teachers' teaching ability according to students

Before analyzing the data, it can be inferred from the bar charts of questions, that students have good perception level towards the Mathematics subject in the three mention aspects that are attitude, interest and perception about teaching methodology.

5.3. Testing of Hypothesis-1: Comparing perception level

This hypothesis is about measuring the students' level of perception of all departments.

Ho: All means are equal that is students from the three departments have the same level of Perception towards mathematics Subject.

Ha: At least one mean is different.

Dependent Variable: Students' Attitude, Students' Interest and Students' perception towards Teaching Methodology).

Independent Variable: The three departments i.e. BBA, BCS and BEE. One-way ANOVA test was used to prove this hypothesis because this test compares the means among three groups on the same variable. Here One-way ANOVA test was performed on one independent variable with more than two categories to check the level of variance among students of three groups (departments): Business Department, Computer Science Department and Department of Electrical Engineering. One-way Anova test was performed for each dependent variable individually.

One-way ANOVA analysis comes up with following assumptions:

5.3.1. Assumption of independence: All groups or departments have unique participant.

5.3.2. Assumption of absence of Outliers: There should be no significant outliers in the collected data. The box plot for outlier detection is generated and then detected outliers are deleted from the data. The box plots for each dependent variable are shown in figure 5, figure 6 and figure 7.

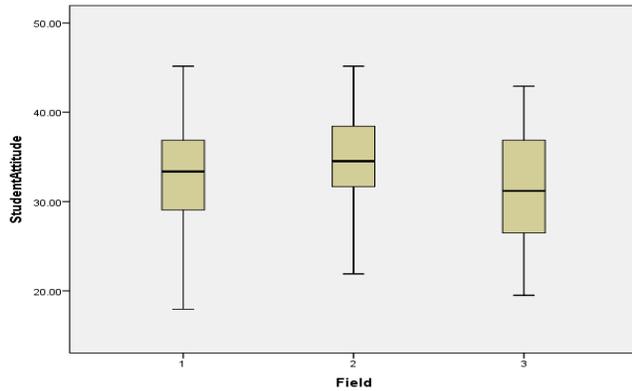


Figure 5. Box plot representing Attitude of students of BBA (1), BCS (2) and BEE (3) departments

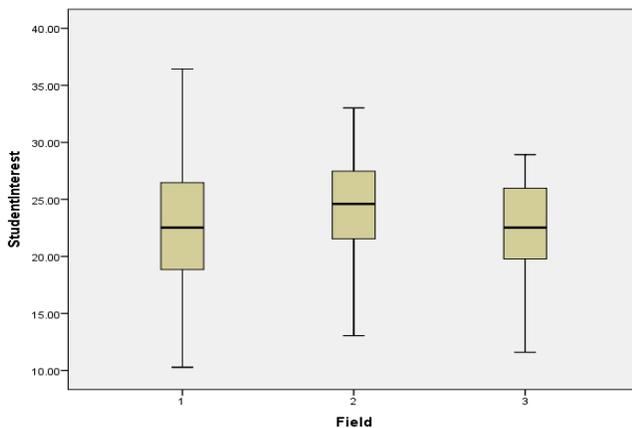


Figure 6. Box plot representing Interest of students of BBA (1), BCS (2) and BEE (3) departments

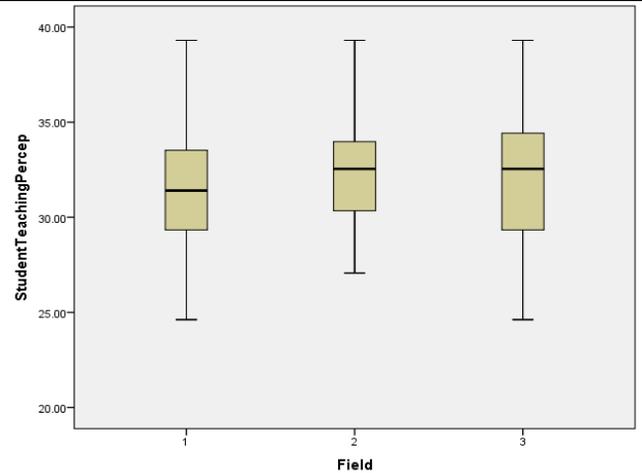


Figure 7. Box plot representing students' Teaching ability perception of BBA (1), BCS (2) and BEE (3) departments

5.3.3. Assumption of normality: The dependent variable should be approximately normally distributed from each group of independent variables. Normality of data is checked through Shapiro-Wilk and Kolmogorov-Smirnov test, as shown in Table II.

Table II. Normality test results

	Field	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	Df	Sig.
Attitude	BBA	.050	186	.200*	.990	186	.252
	BCS	.070	68	.200*	.984	68	.512
	BEE	.126	50	.047	.961	50	.102
Interest	BBA	.055	186	.200*	.990	186	.225
	BCS	.092	68	.200*	.982	68	.419
	BEE	.096	50	.200*	.949	50	.052
Teaching Percep	BBA	.078	186	.057	.985	186	.06
	BCS	.128	68	.048	.965	68	.053
	BEE	.105	50	.200*	.984	50	.727

*. This is a lower bound of the true significance.

As the Significant (p-value) value is greater than α value which is 0.05 for each dependent variable which verifies the normality of data distribution of dependent for each independent variable category.

5.3.4. Assumption of homogeneity of variance: The variances of the distributions in the populations are equal. A Levene's test verified the homogeneity of variances. The table III below shows the Leven's test results.

Table III. Levene's test results

	Levene Statistic	Df1	Df2	Sig p
Attitude	2.194	2	302	.113
Interest	2.105	2	302	.124
Teaching Ability	1.411	2	302	.245

The significances value (p-value) of all variables is greater than alpha ($\alpha=0.05$). So, it can be concluded that there is not a significant difference between the three department's variances.

Now the data is prepared for One-way Anova test as all the assumptions for one-way Anova have not been violated.

- **The Level of Students' Attitude and Interest towards Mathematics**

Table IV. shows the One-way ANOVA results and mean values of attitude and interest among BBA, BCS and BEE.

Table IV. Level of Attitude and Interest among BBA, BCS and BEE

Domain	Mean-Score	SD	F-value	p-value
Attitude				
BBA	3.18	0.84	4.772	0.009
BCS	3.43	0.71		
BEE	2.97	0.86		
Interest				
BBA	2.91	0.79	2.962	0.053
BCS	3.16	0.63		
BEE	2.90	0.69		

Mean value Indicator

Very high:- 4.21 until 5.00

High:- 3.41 until 4.20

Moderate:- 2.61 until 3.40

Weak:- 1.81 until 2.60

Very weak:- 1 until 1.8

Source: Quek Miow Leng (2006), [3]

From results given in Table 4, it can be inferred that mean values for attitude of BBA, BCS and BEE students was 3.18, 3.43 and 2.97 respectively with standard deviation of 0.84 for BBA, 0.86 for BEE students and 0.71 for BCS students. Means that the level of the students' attitude is Moderate for

BBA and BEE programs and high for BCS department according to the mean indicator taken from [3].

There is statistically significant difference between departments according to One-way Anova results ($F(2,302)=4.772$, $p=.009$). A Tukey post hoc test was performed to reveal the departments whose students Attitude level differs. Table V given below presents the results of Tukey Post hoc test for dependent variable Attitude.

Table V. Tukey post hoc test results for dependent variable Attitude

(I) Field	(J) Field	Mean Difference (I-J)	Std. Error	Sig.
BBA	BCS	-.25270	.11611	.077
	BEE	.20801	.12951	.245
BCS	BBA	.25270	.11611	.077
	BEE	.46071*	.15178	.007
BEE	BBA	-.20801	.12951	.245
	BCS	-.46071*	.15178	.007

A Post hoc comparisons using the Tukey HSD test indicated that the mean score for Attitude of BCS department students ($M = 3.43$, $SD = 0.71$) was significantly different than the students of BEE department ($M = 2.97$, $SD = 0.86$) as $p=0.007$. However, mean score of students of BBA department ($M = 3.18$, $SD = 0.84$,) did not significantly differ from the BCS and BEE department students where significance value is greater than 0.05.

Further, the results specify that the mean score for interest of BBA, BCS and BEE students was 2.91, 3.16 and 2.90 respectively with standard deviation = 0.79 for BBA students, 0.63 for BCS students and 0.69 for BEE students. From the mean score indicator, it can be stated that level of the students' interest is moderate for all programs. The results are not showing any significant difference in students' interest level among all departments, as $p\text{-value}=0.090$ that is $p > 0.05$.

From the findings of students' attitude and interest, it can be concluded that the students' level of attitude and interest towards Mathematics for all departments is good. The reason can be a group study, because at that time students solve Mathematics problem more confidently as compared to exams.

• **The level of Students' Perception of Teachers' Teaching Methodology**

Table VI shows the One-way ANOVA results that is F- values and mean values of students' perception of their teachers' teaching methodology among BBA, BCS and BEE.

Table VI. Students' Perception on Teachers' Teaching Methodology

Domain	Mean-Score	SD	F-value	p-value
Teaching Ability				
BBA	2.92	0.82	1.727	0.180
BCS	3.12	0.73		
BEE	3.06	0.89		

Mean value Indicator
 Very high: - 4.21 until 5.00
 High:- 3.41 until 4.20
 Moderate:- 2.61 until 3.40
 Weak:- 1.81 until 2.60
 Very weak:- 1 until 1.8
 Source: Quek Miow Leng (2006), [3]

According to Table 6, the results specify that the mean value for BBA, BCS and BEE students' perception of their teachers' teaching methodology was 2.92, 3.12 and 3.06 respectively with standard deviation = 0.82 for BBA, 0.73 for BCS and 0.89 for BEE students. It can be inferred from the results that the students' perception level about teaching methodology of their teachers is moderate for all departments' students according to mean score indicator. There is no significant difference shown in the results among students' of all departments as (p-value=0.18 that is p> 0.05).

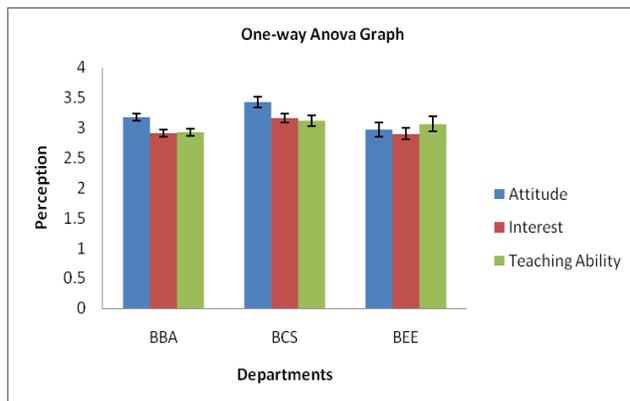


Figure 8. One-way Anova results

Figure 8 presents the graph for One-way Anova results. From the graph, it is clear that Attitude level of students of BCS department is different as compared to BBA and BEE department, as the standard error bars of BCS students attitude level are not overlapping.

5.4. Hypothesis-II Testing: Comparing Perception level of gender Categories

This hypothesis compares the perception level of male and female students. Here students from all three departments are divided in two groups male and female.

Ho: two populations i.e. Male and female students have same means.

Ha: Atleast one mean is different.

Independent Variable: Gender categories (Male and Female)

Dependent Variable: Total Perception

where,

$$\text{Total Perception} = \text{Students' Attitude} + \text{Students' Interest} + \text{Students' perception towards Teaching Methodology}$$

Independent t-test is used to prove this hypothesis because this test compares the means between two unrelated groups that are male and female on the same dependent variable i.e. Total Perception.

To test the hypothesis that the male students' perception (N=185, M=2.89, SD=0.85) and female students' perception (N=120, M=2.86, SD=0.73) means were equal, an independent sample t-test was performed. Prior to conducting the analysis, the assumption of normality distributed differences was examined. The assumption was considered satisfied. Furthermore, the assumption of homogeneity of variances was tested and satisfied based on Levene's test for equality of variances F=4.07, p=.055.

Table VII. shows the Independent t-test results and mean values of total perception among male and female group of students.

Table VII. Independent t-test results

Domain	Mean-Score	SD	F-value	p-value
Total Perception				
Male	2.89	0.85	4.07	0.78
Female	2.86	0.73		

Mean value Indicator
 Very high: - 4.21 until 5.00
 High: - 3.41 until 4.20
 Moderate: - 2.61 until 3.40
 Weak: - 1.81 until 2.60
 Very weak: - 1 until 1.8
 Source: Quek Miow Leng (2006), [3]

According to Table III, It can be inferred from the results that the students' total perception level is moderate for both groups of independent variable according to mean score indicator. There is no significance difference shown in the results between male and female groups as (p-value=0.78 that is p> 0.05).

A bar chart is presented in figure 9 to visualize the t-test results.

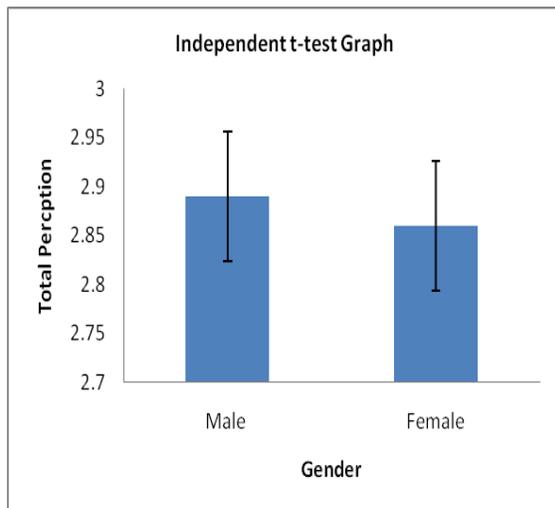


Figure 9. Independent t-test bar chart

Again from the t-test it can be inferred that male and female students have same and significantly moderate level of perception as the standard error bars for both male and female are overlapping. Hence, null hypothesis is accepted as there is no difference in means between both groups.

5.5. Hypothesis-III Testing: Investigating performance relevance with gender discrimination

This hypothesis will investigate that how much subject performance is affected by gender discrimination. Do female students perform better than male students?

Ho: Both Male and Female students of all departments performed equally well in Mathematics Subject.

Ha: Male students perform better than female or vice versa.

Independent Variable: Gender i.e. Male and Female categories

Dependent Variable: Subject Performance

A point-biserial correlation will be used to measure the strength of the association that exists between one dependent variable and one dichotomous variable, which is gender in this case. It is a special case of Pearson product moment correlation.

All the assumptions for the biserial correlation are checked and no assumption is violated.

The biserial correlation (r) results are given in Table VIII.

Table VIII. Relationship B/W gender variables(male/female) And Mathematics' Scores

Correlation Results		
Perception	Pearson Correlation, r	0.037
	Sig. (2 tailed)	0.519

*p<0.01

Strength Indicator
 Very high: - 0.91 until 1.0
 High :- 0.71 until 0.9
 Moderate :- 0.41 until 0.7
 Weak :- 0.21 until 0.4
 Very weak :- 0.00 until 0.2
 Source: Quek Miow Leng (2006), [3]

The resulting value (r = 0.037, p > 0.01) represents a positive and a very weak but a significant relationship between students' perception and Mathematics result. The correlation value of 0.037 is very low which shows a negligible relation of students' performance in the subject with gender discrimination.

So, we can reject the null hypothesis that is no correlation between students' perception towards the subject and their Mathematics results. From the strength indicator, it is cleared that the relationship's strength is very weak.

5.6. Relationship between Students' Perception and Mathematics result

The objective of the study is to identify the relationship strength and direction between students' perception towards the Mathematics subject and students' performance that is their scores in Mathematics subject of BBA, BCS and BEE students in Institute of Business Administration, Sukkur University.

This hypothesis will investigate the strength of relationship between students' perception and students' performance in mathematics subject.

Ho: There is no correlation between students' perception and student's performance in the Mathematics Subject.

Ha: There is a significant and strong relation between students' perception and their scores in the Mathematics Subject.

Independent Variable: Students of three departments

Dependent Variable: Subject Performance

The correlation results based on the formula of Pearson Product Moment Correlation (r) are given in Table IX.

Table IX. Relationship B/W Student's Perception and Mathematics 'Scores

Correlation Results		
Perception	Pearson Correlation, r	-0.059
	Sig.(2 tailed)	0.308

*p<0.01

Strength Indicator

Very high:- 0.91 until 1.0

High :- 0.71 until 0.9

Moderate :- 0.41 until 0.7

Weak :- 0.21 until 0.4

Very weak :- 0.00 until 0.2

Source: Quek Miow Leng (2006), [3]

The resulting value (r = -0.059, p > 0.01) represents a negative and a very weak but a significant relationship between students' perception and Mathematics result.

So, null hypothesis can be rejected, which implies that there is no correlation between students' perception towards the subject and their Mathematics results. From the indicator, it is cleared that the relationship's strength is very weak and negative. The correlation value (r= -0.059) specifies that there is a negligible impact of students' perception on performance in mathematics subject and it is further described from the scatter plot given in figure 10.

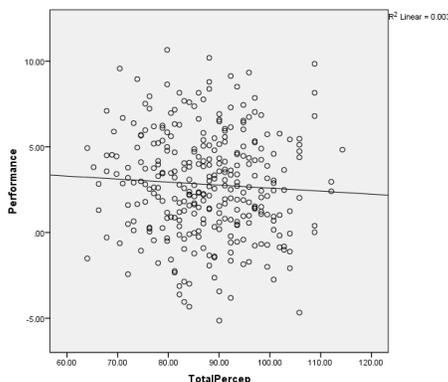


Figure 10. One-way Anova results

6. Conclusion and Future Work

The study found that there is no impact of student's perception students' performance in Mathematics. It can be analyzed from the results that students' perception level that is attitude, interest and teachers' teaching methodology; is good and encouraging. Male and female students' perception does not differ, and their perception does not have any effect on their mathematics performance. There is a very weak relationship between students' perception and Mathematics' result.

The low performance can be caused by other factors such as no parental support, and inconsistent assessment and weak Mathematics foundation. Students solve mathematics problem more confidently while working in groups by confirming the solutions and answers than solving those in examination hall. The study removes certain misconceptions and myths regarding mathematical courses. Teaching methodology and student's perception were widely considered as major setback for students' poor performance in mathematics. However, the numbers suggest that there may be some factors that can be identified by other researchers in future.

The study is applied only to the Sukkur IBA University. Therefore, the results may vary for other institutes.

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