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Relationship Between Analysis Data Statistical Thinking and Statistics Achievement: A Survey of University Undergraduate Students in Khyber Pakhtunkhwa, Pakistan

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Abstract
The study explores the magnitude of Analyzing data Statistical thinking (ADST), Statistics Achievement (SA), and relationship between ADST and sub-factors of SA with ADST. 360 Undergraduate were selected from the population. Multi multistage stratified random sampling technique was used in the selection of samples. ADST test was used for the purpose of data collection. Mean, standard deviation and Pearson correlation coefficient were used to analyze the data. Means were compared with the t test statistic, and ANOVA was used for the interaction effect of gender and school sector. From the results of the study, it was concluded that SA has a statistically significant and strong Positive correlation with ADST and their sub factors. Gender-wise statistically significant differences exist in the means score of ADST and SA. The university sector-wise statistically significant differences do not exist in the means score of ADST and SA at the 0.05 level of significance. Gender and sector-wise interaction effect on ADST and SA is statistically significance does not exist on the means score.

Keywords: Statistical Thinking, Analyzing Data, Statistics Achievement, Aspects of Analysis Data

Introduction

Society expects that academic achievement is the outcome of the provision of education in universities; therefore, society looks for outstanding universities, and the policy dictates what a good university is. The effectiveness and efficiency of a university are analogous to the effectiveness of the education system in our country. Effectiveness of a university translates into students' achievements. Therefore, this study is also concerned with students' achievement and is focused on the theory of statistical thinking and statistical achievement. Central to this thesis is the relationship between Analyzing Data, the Aspect of statistical thinking and statistical achievement in relation to background variables like gender and university sector. Statistics is observed as a dry subject at the university level, and therefore student achievement in statistics has always been an important topic for discussion among teachers, parents, and researchers. Low achievement in statistics is undoubtedly due to the teaching of statistics, as it is taught in university in a way that is mostly outcome-based and teacher-centered (Warwick & Reimers, 1995), where teachers often solve questions on the blackboard and students note them in their notebooks, ignoring the process-based teaching with a focus on understanding, reasoning, critical thinking, and creativity (Halai, 1998).

Over the years, statistics have become progressively more important at the university level. This claim is confirmed by the first look into history. At the start of the 20th century, most researchers considered those statistical techniques not to be applicable and simply not suited to improve our knowledge of the social sciences. And most of them considered that statistical techniques were only applicable in the

natural sciences, and that was the time when social sciences were just separated from natural sciences and other disciplines. That was a time of maturation of these disciplines. By the end of the 20th century, all these misconceptions about statistical techniques were changed. And now, statistical techniques are used as standard, and they have become more important in all disciplines.

And now, the use of statistical techniques is omnipresent. Most university students depend on statistical techniques for the analysis of data and testing of hypotheses, and the university students are now using different statistical techniques for understanding the social world.

Almost all over the world, students of social sciences and arts have a very narrow knowledge of the importance of statistical techniques and the effects of statistics on social life. Their statistical knowledge is banked on a formula-based approach, and is not practically applicable (Boland, 1996). In these situations, this is the cry of the day that both students and their teachers must gain knowledge about the importance of statistics in social life and the challenging and applicable nature of statistics in the field of social sciences, as well as how modern life relies on different statistical techniques. It is suggested that the important issue in this context is that the statistical examples must be relevant to the local society, and this is very important for underdeveloped countries as they depend on technologically advanced countries for their educational equipment (Boland, 1998).

Statistics are an important part of cognition and thinking. The development of a student's Analyzing Data, the Aspect of statistical thinking is one of the main objectives of statistical curriculum and instruction (Lutfi, 1998).

According to (Snee, 1990; Britz, Emerling, Hare, Hoerl, & Shade, 1997), Analyzing Data, the Aspect of statistical thinking is well-defined as thought processes which recognize the variation that is present everywhere and in everything we do. All works are a series of interconnected processes, identifying, characterizing, quantifying, controlling, and reducing variation that provide openings for improvement.

Statistical Thinking and Its Aspects

One of main parts of human nature is thinking, that allows every human being to get a clear view of the reality present in world. Burton (1984) defines that thinking are the ways used by human beings to develop their understanding and exercise some control over their environment; to improve thinking skill in the students, different disciplines are used mainly in statistics and mathematics.

So many books and research articles used the word "statistical thinking" in their headings. But few of them give a complete and clear definition of statistical thinking. In most of the textbooks and research papers use the phrases statistical thinking, statistical reasoning and statistical literacy in the same meanings but the difference among these terms must be cleared by the following definition (Chance, 2002)"

The foundation of statistical thinking is based on the following four elements: to check and know about variations; knowledge of how to construct models and to think about models; must have some basic knowledge of statistics and context domain; and integration (Pfannkuch & Wild, 1998).

Statistics is working as a helper subject for all other subjects. For all the research problems a statistician works on, it is entrenched into a big problem, the natural problem. Around this big and natural problem is a body of context knowledge. The main objective of learning is to improve knowledge and understanding of the context. In general, learning is not only about collecting data and information; it also includes the introduction of new values and information with current values and information.

Definitions Statistical Thinking

The definition of statistical thinking is based on Deming's theory of Profound Knowledge, which has four parts:

- To appreciate the system
- To know about variation
- To know about theory of knowledge
- Psychology

The first principle of statistical thinking is from the theory of profound knowledge part first, that all

work happens in a system of organized processes. The second and third principles of statistical thinking, that variations are present in all processes and to understand and reduce variations are the secrets to success, come from profound knowledge part two (Britz, Emerling, Hare, Hoerl, & Shade, 1997). Statistical thinking is well-defined as thought processes, which recognize that variation that is present everywhere and in everything we do, all works is a series of inter-connected processes, identifying, characterizing, quantifying, controlling, and to reducing variation that provides improvement (Snee, 1990)

The definition given by the American Statistical Association (ASA) / Mathematical Association of America (MAA) joint committee on undergraduate statistics as,

- The importance and need of data
- Production of data is important
- Variation is present everywhere
- The measurement of variations and develop model for variability (Cobb, 1999)

The American Statistical Association working Committee on statistical thinking suggested:

- The measurement of probability and variation in the data and their effect on decision making
- Use of scientific techniques for approaching issues and problems (Sylwester, 1993)

The relationship of quantitative data and real-world problems, sometimes in the existence of variation and uncertainty will help to make accurate and clear decisions about data and problem understudy (Mallows, 1998).

In any statistical inquiries, first of all examine the set of data, construct the graph from the data and interpret it, look all the patterns and check the deviations in those patterns, try to find reasons for the problem understudy; on the basses of examination of the data, choose suitable numerical values of specified aspects; check overall pattern and if it is satisfactorily regular then find appropriate and complete mathematical model for that pattern (Moore 1999).

Analysing Data Statistical Thinking

The important aspect of statistical thinking processes is analyzing data. Analyzing data came into play after the first three aspects of statistical thinking. In analyzing data, the trends are identifying from the data and inferences drawn for population or predictions drawn from tables, charts or graphs (Mooney, 2002). Analyzing data includes the comparisons within the set of data or displayed data, the comparisons between the different sets of data or displayed data and inferences drawn from displayed data (Curcio, 1987).

There are two categories included in the analyzing data, to read between the set of data and to read beyond the data sets, the first one “to read between the set of data” includes of making comparison within and among data sets, and second one “to read beyond the data set” includes of making inferences from data sets.

Analyzing data is related to recognizing trends and to make inferences about population parameters or future predictions from the data sets. There are eight sub processes in the analyzing data process.

The first of the sub process is related to the comparison of patterns of single variable data sets. Researchers conducted several studies on middle and high school students to compare their skills in analyzing univariate data sets (Watson & Moritz, 1999a; McClain & Cobb, 2001).

The second sub process is related to analysis of the relationship between sample statistics and the population parameter. To understand the relationship between a value calculated from the sample and a value calculated from the population is an important portion of this aspect of the statistical thinking (National Council of Teachers of Mathematics [NCTM], 2000).

The third sub process is related to find of a typical point within a tabulated data. This sub process of analyzing data is making comparisons within data sets, category of reading between the data (Curcio, 1987).

The fourth sub process is related to the construction of pattern of responses to make multiplicative comparisons. The last four sub processes all related to student’s analysis of two variable sets of data that contain two variables for measurement. The pattern of responses is important when students identify a typical point in bivariate set of data. Interpolation of data and extrapolation of the data are

the next two sub processes examined and described. At the last, responses given the tasks related to the description of the relationships between two variables directed to identify the pattern of responses for the sub process of describing bivariate relationship when both variables are measurement variables (Groth, 2003).

Q1.An IQ test was taken by four students. Their scores are 95, 101, 105, and 115. Which of the following statements is true?

I. Mean is 103 II. Mean is 104 III. Median is 100 IV. Median is 106.

Choose Correct Option

a. A. I only B. II only C. III only D. IV only
b. Why this option is correct _____
c. Why other options are incorrect_____

Analysing Data Statistical Thinking and Statistical Achievement with Gender Comparisons

This section of the study is related to review the research studies regarding statistical thinking and achievement in statistics with their relation to the background variable gender.

Gender and Analyzing Data Statistical Thinking

A wide range of research studies have been conducted about gender differences in learning students in the science subjects, statistics, mathematics, finance, and economics. Generally, in these most of these disciplines, male student's performance is better than female students, but this pattern is not obvious in statistical thinking (Haley, Johnson , & Kuennen, 2007).

Gender learning difference can also be seen at school age; for example, the National Assessment of Educational Progress (NAEP) conducted a study among nine-year-old students, they observed that male student's performance was better than female students in the statistics, mathematics and science tests, but in reading of science subject, male score lower than female students. At the age of college and university these gaps become statistically significant, these gaps also affecting student's choice of major subject (Dee, 2007).The trends showing that women are enrolling at higher percentages at university and graduating from university at higher percentages than men, but men continue to perform better than women some in disciplines like mathematics, engineering, finance, and economics (Freeman 2004). But in the fields of Analyzing Data of statistical thinking, mathematics and economics, at undergraduate level women comprise a higher percentage than men (Scheaffer & Stasny 2004). Buck (1985) hypothesized that gender differences may affect student's statistical thinking in many ways, in class male students may get more attention of professors than female students, female student may be more sensitive to role model effect then male students, professors' expectation about gender differences students' performance or gender may expressively affect statistical thinking skills. However, when the examination was conducted of her psychology statistics students (at introductory and advanced undergraduate level), Buck concluded that there is no statistically significant difference in statistical thinking of both genders.

Gender and Statistical Achievement

There has been some research to show that male achievement is better than female when course grades are determined mainly by examinations and female achieve better when course grades are is determined mainly by homework (Dynan & Rouse 1997; Robb & Robb 1999). Haley, Johnson , & Kuennen (2007) conducted a research study on students and professors' gender effects in elementary statistics, and the main objective of the study was to measure the effects of student's gender on achievements in elementary statistics. The study was conducted in University of Wisconsin – Oshkosh. The study was based on a large sample of 535 elementary statistics students selected from different sections of three semesters. They investigated the effects of students' gender on achievement in elementary statistics courses taught by economics teachers. They determine that student's gender and professor's gender are not statistically significant effect on student achievement in elementary statistics. But our two regressions did not give a clear picture of the relationships between course performance and gender because they were not controlled for interaction between students and

professors gender. They found that students taught by a professor of the opposite gender are significantly worse than students taught by a professor of the same gender. In majority cases male student's statistical achievement is better than female students in an introductory statistics course (Johnson & Kuennen, 2006). While Harraway (2002) concludes that there was no male to female significant difference in statistical achievement of the students in an introductory biostatistics course in New Zealand.

Public and Private Sector Universities in Khyber Pakhtunkhwa

Education system in Khyber Pakhtunkhwa is mainly divided into two parts i.e. religious institution and mainstream institution. The variety in the universities systems of KPK further has two impotent categories i.e. government sector universities and private sector universities. Both of the systems are alike in educational structures and follows the same curriculum designed by the higher education commission of Pakistan and English is the medium of instruction in all public and private sector universities of KPK. The key difference in these two types of sectors is the administrative autonomy that the private universities enjoy by virtue of which they can take a university level decision including teacher's recruitment. Another main difference is university financing, where public universities are financed by public funds and also charge their students for tuition fees, while private universities charge their students for tuition fees directly and do not get any financing from government. Also, public sector universities often run under poor regulatory environments. There are ten Private and nineteen public sector universities in Khyber Pakhtunkhwa.

Public and Private Sector Universities Comparison in Statistical Achievement

In Australia, Public and Private school and universities students were compared using international and national test results, one group of studies has used the results of Program for International Student Assessment to compare the results of students in public and private schools and universities. The 2012 national Program for International Student Assessment report shows that there was no significant difference between the results of public and private universities and schools, in statistics, mathematics and science subject reading (Thomson, De Bortoli, & Buckley, 2013).The national results from Program for International Student Assessment 2009 also showed no significant difference exist between public and private sector schools and universities (Thomson, De Bortoli, Nicholas, Hillman, & Buckley, 2010). The results for Australia, and many other countries, indicate that socio-economic differences have a much larger impact on student achievement. For example, 56 per cent of the total variation in mathematics and statistics achievement in Program for International Student Assessment 2012 was explained by socio-economic differences between schools and six per cent by socio-economic differences between students within schools (Thomson, De Bortoli, & Buckley, 2013).

Research work on this particular aspect of investigation and Analyzing Data, the Aspect of statistical thinking ability and its relationship with statistical achievement is rare. Therefore, to inquire about the problem of low achievement, the relationship between Analyzing Data aspect of statistical thinking and statistical achievement was focused on this study with further comparison of gender-wise and sector wise among university students in Khyber Pakhtunkhwa, Pakistan.

Objectives of the Study

The following were the objectives of the study

1. To explore the Analyzing Data Aspect of statistical thinking and statistical achievement as well as their relationship, among the university Undergraduate Students in Khyber Pakhtunkhwa, Pakistan.
2. To explore the differences in the Analyzing Data Aspect of statistical thinking and statistical achievement based on gender and school sector among the university Undergraduate Students in Khyber Pakhtunkhwa, Pakistan.
3. To investigate the interaction effects of gender and University sector on the Analyzing Data Aspect of statistical thinking and statistical achievement among the university Undergraduate Students in Khyber Pakhtunkhwa, Pakistan.

Theoretical Framework

This study mainly concerned with the relationship between statistical achievement and Analyzing Data Aspect of statistical thinking. Achievement is usually defined as to do work to achieve something or in other words successfully completing the given task. In this study Statistical achievement is the marks or numerical scores obtained by students in the B.S (Hons) course of statistics. Analyzing Data Aspect of Statistical thinking, in this study is measure of Analyzing Data Aspect of statistical thinking, discussed in detail The term Statistical thinking were not very much defined in the past. Most of the statisticians have tried to define the nature of statistical thinking and to define and list different aspects of statistical thinking but no one can be labeled as exclusive.

The five non-disjoint aspects of statistical thinking process are describing data, organizing and reducing data, representing data, analyzing data, and collecting data. In this section, Analyzing Data Aspect of statistical thinking process will be discussed.

The important aspect of statistical thinking processes is analyzing data. Analyzing data came into play after the first three aspects of statistical thinking. In analyzing data, the trends are identifying from the data and inferences drawn for population or predictions drawn from tables, charts or graphs (Mooney, 2002). Analyzing data includes the comparisons within the set of data or displayed data, the comparisons between the different sets of data or displayed data and inferences drawn from displayed data (Curcio, 1987).

Many factors are involved in the students' learning and in the achievement of the students. To get a clear picture for the sample of this study, the population of this study was divided into two subsections; gender (male and female), and two sectors (public and private sector) of the universities were taken as the background variable. Gender is well-known to everyone and in this study it is not taken as biological phenomena rather it is taken as the attributes set by the social phenomena (Unger & Crawford, 1992). Although different theories related to biological explanations for sex differences in achievement in statistics have been advanced (Benbow, 1982) but social and cultural explanations are more generally accepted (Humphreys, Lin, & Fleishman, 1976; Meece, Eccles, Kaczala, Goff, & utterman, 1982; Sherman, 1978).

In Pakistan private sector universities are those universities which are run by an organization or person most of the time for personal profit motives and for self-employment (Shami, 2004). Private university sector is one of the growing sectors in Pakistan, attracting a larger number of population and most of them are richer who is able to afford, to enroll their children in private sector universities. The private sector was included in study which may be helpful to understand the effects of socio-economic status on the student's achievement (Ma'moon, 2005).

On the other hand, public sector universities in Pakistan are universities which are run by government of Pakistan. There is a common view that public sector universities are more efficient than private sector universities (Hanushek, 1997).

Methodology

Quantitative method of research strategy was applied in the current research study. Salvador, J. T. (2016) defined quantitative research is the systematic pragmatic examination of obvious phenomena through statistical techniques, mathematical techniques or computational techniques (Ali,A 2023).

Population of the Study

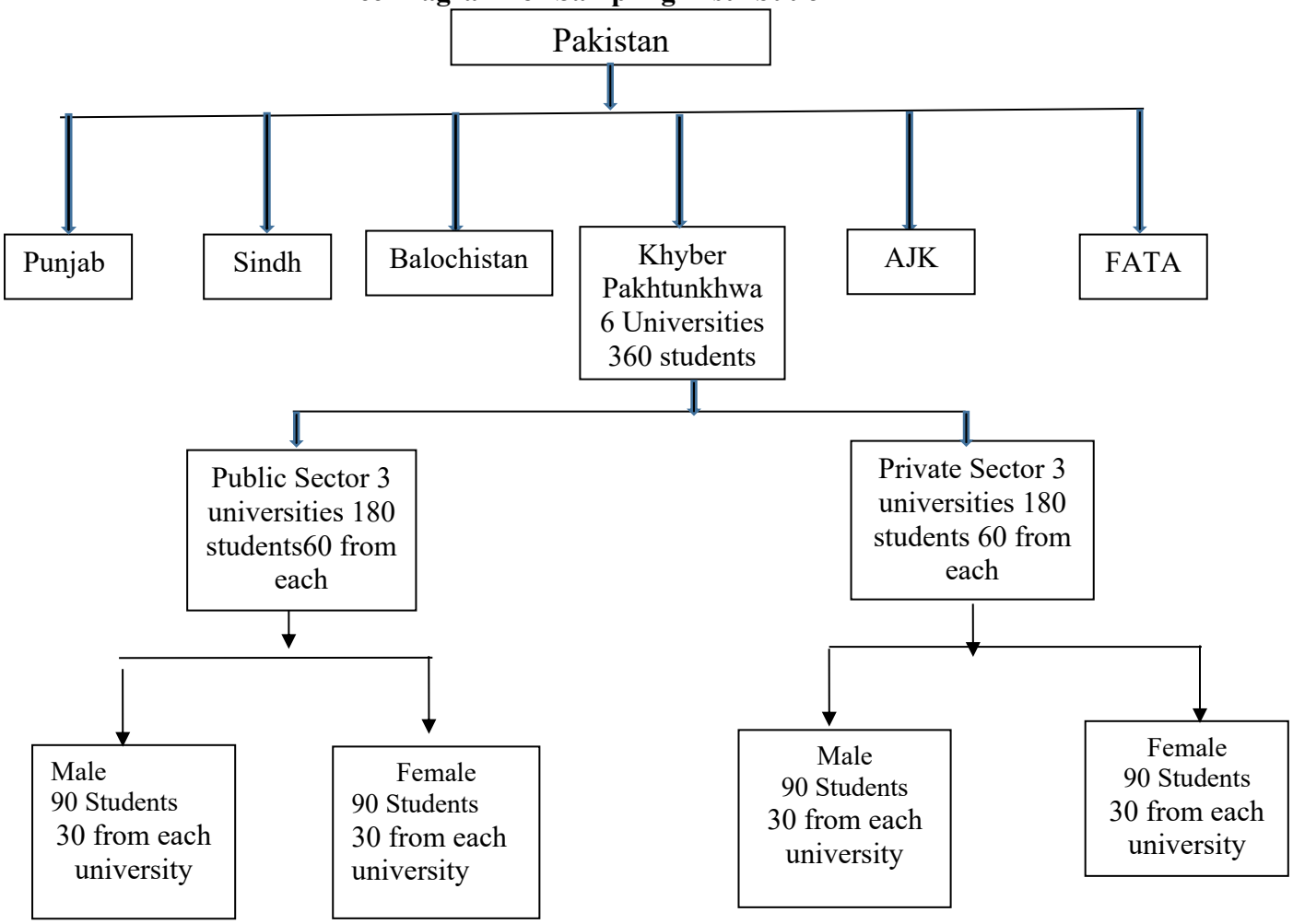
The study's population comprises secondary school administrators in Khyber Pakhtunkhwa, a province in northern Pakistan. The province spans 101,741 km2, with a population of approximately 35 million. Khyber Pakhtunkhwa of Pakistan is a northern province of the country with total population of 22 million in 2008. The number of universities in the province is 29 out of which 19 are public sector and 10 are private sector universities (Higher education commission annual report 2012-13). According to the higher education commission annual report 2012-13, 73392 students enrolled in all higher education institutes in Khyber Pakhtunkhwa. The gender wise percentage as per higher education commission annual report 2012-13 is 55 percent male and 45 percent female students were

enrolled in the universities in Khyber Pakhtunkhwa.

Sample for Study

A multi staged stratified random sampling technique was used to draw sample from population for collection of quantitative data. In stratified random sampling the heterogeneous population was divided into homogenous groups' i.e. public sector and private sector. In this technique, a comparatively large number of sample units are selected from a population, or from particular sub-groups (strata) of a population, in a random way probability of selection for each and every unit of the population is same (Tashakkori & Teddlie, 2003). Stratified random sampling was opted because it gives representation to different strata along with minimizing sampling error. The sample size was decided on the basis of sampling error of 4% with 95% confidence interval and assuming that a student had 30% chances participating in the studies. 3 public sector and 3 private sector universities were selected randomly from both strata. 360 students were randomly selected, 50% from the public sector and 50% from private sector. From both public and private sectors 50 % male and 50% female were selected as a sample. 60 students were selected from each public and private university in which 30 male and 30 female.

Tree Diagram for Sampling Distribution



Development, Content Validity of the Test of Analyzing Data Aspect of Statistical Thinking

A test was developed for the assessment of data analyzing aspects of statistical thinking of the university students. Analyzing data aspect of statistical thinking was discussed earlier , was taken as foundation for construction of test. Test included 25 items analyzing data aspect of statistical. Items for the test of analyzing data aspect of statistical thinking were developed by the researcher according to the curriculum of B.S (Hons) university students. This collection of items was then sent to experts

i.e. teacher educator and practicing teachers for comments. Item analysis was performed after trial testing before finalizing the test for main study in the light of experts' comments and trial testing.
The test development was used to check the reasoning and thinking power of the university students and use of questions like why this option is correct. Show your work? And why are other options wrong?
After deciding about the number of items, some items were revised by the researcher. And the test of statistical thinking Question no 3 of organizing and reducing data and question no 5 of collecting data was revised in light of experts' comments. Some changes were also made to the content of some items as directed by experts. When all these changes were made in the test, then the test was piloted to check the reliability of the test.

Content Validity of the Test of Analyzing Data Aspect of Statistical Thinking

Content validity is an important characteristic for any measurement tool and shows that how relevant the tool to the learning universe of the subjects under study. It is defined as Content validity is assessed by showing how well the content of the test samples the class of situations or subject matter about which conclusions are to be drawn. In other words, Content validity is indicated by a description of the universe of items from which selection was made including a description of the selection process. Content validity affects the inferences that can be drawn from the sample data. To ensure the content validity of the test of Statistical Thinking, this test was then sent to 5 experts for comments. On the basis experts' comments some questions were modified.

Reliability of the Tests of Statistical Thinking

The background of establishing reliability involved numerous data collecting strategies, reporting any possible personal biasedness and decisions made about data and categories (Burns, 2000). Reliability of the test is also related to the number of available items, and the new added item is not poorly constructed. Reliability was also used to measure the internal consistency method, commonly by using Cronbach's Alpha coefficients and its alternatives by using Statistical Package for Social Sciences SPSS version 21.

Reliability Statistics for Test of Statistical Thinking

Cronbach's Alpha	Cronbach's Alpha based on standardized items	Number of Items
.905	.905	25

The above Table indicates that overall reliability of the statistical thinking test was 0.905 which is good value for basic analysis (Nunnally, 1978).

The value of reliability is dependent on the number of items used in this test then, as Field (2005) noted that the value of Cronbach's alpha is directly proportional to the number of items in test, even controlling for the same level of average inter correlation of items. This assumes, of course, that the added items are not bad items with low reliability as compared to the existing set of items. Increasing the number of items can be a way to push alpha to an acceptable level. The reliability of each Individual item was also calculated separately to check whether any of the items is affecting overall reliability of the test. The individual item reliability was revolving around the reliability measure of 0.905 for the whole test and no item was found badly affecting the reliability of the test therefore all items were used for the study.

Item wise Reliabilities Analysis for Test of Analyzing data Aspect of Statistical Thinking

Item	scale mean if item deleted	Cronbach's Alpha if item deleted	Item	scale mean if item deleted	Cronbach's Alpha if item deleted
AD1	59.69	.902	AD14	59.63	.900
AD2	59.63	.903	AD15	59.73	.901
AD3	59.62	.903	AD16	59.68	.900
AD4	59.63	.900	AD17	59.68	.900
AD5	59.67	.899	AD18	59.63	.902
AD6	59.65	.902	AD19	59.69	.899
AD7	59.62	.904	AD20	59.74	.897
AD8	59.63	.905	AD21	59.71	.902
AD9	59.62	.901	AD22	59.67	.902
AD10	59.65	.901	AD23	59.63	.903
AD11	59.68	.903	AD24	59.69	.900
AD12	59.59	.900	AD25	59.68	.899
AD13	59.61	.904			

Scoring Rubric for Test of Data analysis Statistical Thinking

Response score	Description
0	Did not attempt or no answer or irrelevant, completely incorrect attempt.
1	Selection of correct option without justification. No or incorrect reasoning. Response shows a complete lack of understanding of the problem.
2	Selection of correct options with weak justification of both correct and incorrect option. Response shows some understanding of the problem.
3	Selection of correct option with strong justification of correct option and with weak justification of incorrect option. Shows substantial understanding of the problem, ideas, and processes.
4	Selection of correct options with strong justification of both correct and incorrect options. Shows complete understanding of the questions.

Analysis Of Data

Description of Students' overall Achievement in all Aspects of Data analysis Statistical Thinking

	Minimum	Maximum	Mean	Std. Deviation	N
Formulating Hypotheses	0	20	12.46	3.721	360
Designing Studies	0	20	12.54	3.543	360
Summarizing Data	0	20	12.45	4.044	360
Making Inferences	0	20	12.28	3.903	360
Interpreting Results	0	20	12.29	3.656	360

Table above shows that the mean score of Making Inferences and Interpreting Results (12.28 and

12.29) was low for all students which shows the high difficulties level of these two aspects and the mean score of Designing Studies (12.54) is high for all the students which shows that easiest aspects. The standard deviation of Designing Studies is 3.543 which is lowest among all the aspects which indicates that variation in the student's thinking ability of Designing Studies was minimum and standard deviation of the aspect Summarizing Data is 4.044 which is highest among all the aspects which indicates that the variation in student's thinking ability of Summarizing Data is maximum. Total score for statistical thinking and statistical achievement was 100.

Description of Students' Data Analysis Statistical Thinking and Statistical Achievement

	N	Minimum	Maximum	Mean	Std. Deviation
Analyzing Data Statistical Thinking	360	8	97	62.14	14.170
Statistical Achievement	360	35	89	70.55	8.342

Table above indicates that the mean score of Analyzing Data statistical thinking is 62.14 with standard deviation of 14.170 and mean score statistical achievement 70.55 with standard deviation of 8.342.Relationship between Analyzing Data and statistical achievement was the main objective in this thesis. The relationship between these two main variables along with relationship of individual aspect of Analyzing Data statistical thinking with statistical achievement was determined using Pearson correlation coefficient.

Pearson Correlation Coefficient of Aspects of Analysis Data Statistical Thinking with Data Analysis Statistical Thinking (Total) And Statistics Achievement

	Statistical Achievement	**Formulating Hypotheses**	**Designing Studies**	**Summarizing Data**	**Making Inferences**	**Interpreting Results**
Data Analysis statistical thinking	.656**	.765**	.681**	.715**	.852**	.816**
Statistical Achievement		.481**	.562**	.412**	.651**	.410**
Formulating Hypotheses			.418**	.391**	.570**	.560**
Designing Studies				.311**	.504**	.417**
Summarizing Data					.505**	.482**
Making Inferences						.675**

** Correlation is significant at P< .01

Table above shows that correlation coefficients of data analysis statistical thinking with statistical achievement are 0.565 which is significant at p<0.01.All the coefficients of different aspects of data analysis statistical thinking with statistical achievement were significant. There was considerable variation in correlation of different aspects of statistical thinking with scores in the test of statistical achievement ranging from 0.418 with collecting data to 0.651 with Making Inferences. These aspects were highly correlated with the total score of data analysis statistical thinking ranging from 0.681 with Designing Studies to 0.852 with Making Inferences. All sub scales were also moderately correlated with one another with minimum correlation found between Summarizing Data and Designing Studies Summarizing Data with coefficient of 0.311 and maximum correlation of .675 between Making Inferences and Interpreting Results.

t-Test of Gender Wise Comparison of Statistical Achievement

Mean Female Male		Standard deviation Female Male		t	d.f	Sig.(2-tailed)	Effect size Cohen's d
69	72	8.3	8.1	-3.523	358	.000	0.36

Table above shows that the mean score for statistical achievement for female was 69 and for male was 72 which means that male performance in statistical achievement is better than female. The standard deviation for female was 8.3 and for male was 8.1 which means that there is greater variation in female students scores than male in statistical achievement. The significance (2 tailed) value is 0.000 which means that gender wise, statistically significant difference exists in the mean score of statistical achievement. To elaborate the difference further Cohen's D effect size was also calculated, Effect size Cohen's D was found 0.36 which shows medium effect size in statistical achievement.

t-Test of Gender Wise Comparison of Data Analysis Statistical Thinking

Mean		Standard deviation		t	d.f	Sig.(2-tailed)	Effect size Cohen's d
Female	Male	Female	Male				
61	64	14.1	12.1	-.3.417	358	.009	0.14

Above table shows that the mean score for Data Analysis the aspect of statistical thinking for female was 61 and for male was 64 which means that male performance in data analysis aspects of statistical thinking was better than female. The standard deviation for female was 14.1 and for male was 12.1 which means that there is greater variation in female students scores than male in statistical thinking. The significance (2 tailed) value is 0.009 which is less than 0.05 means that, gender wise, statistically significant difference exists in the mean score of data analysis statistical thinking. To elaborate the difference further Cohen's D effect size was also calculated, Effect size Cohen's D was found 0.14 which shows small effect size in data analysis aspects of data analysis statistical thinking.

t- Test of Sector Wise Comparison of Analysing Data Statistical Thinking

Mean		Standard deviation		t	d.f	Sig.(2-tailed)	Effect size Cohen's d
Private	Public	Private	Public				
12	13	4.1	3.6	-1.421	358	.156	0.26

Table above shows that the mean score for analyzing data statistical thinking for private sector university students was 12 and for public sector university students it was 13 which means that public sector university student's performance in analyzing data statistical thinking was better than private sector university students. The standard deviation for private sector university was 4.1 and for public sector university students it was 3.6 which means that there is greater variation in private sector

university students scores than public sector university students in analyzing data statistical thinking. The significance (2 tailed) value is 0.156 which is greater than 0.05 means that sector wise, statistically significant difference does not exist in the mean score of analyzing data statistical thinking. To elaborate the difference further Cohen's D effect size was also calculated, Effect size Cohen's D was found 0.26 which shows medium effect size in analyzing data statistical thinking.

t – Test Sector Wise Comparison Of Statistical Achievement

Mean		Standard deviation		t	d.f	Sig.(2-tailed)	Effect size Cohen's d
Private	Public	Private	Public				
71	70	8.5	8.2	1.271	358	.205	0.11

Table above shows that the mean score for statistical achievement for private sector university students was 71 and for public sector university students it was 70 which means that private sector university student's performance in statistical achievement was better than public sector university students. The standard deviation for private sector university was 8.5 and for public sector university students was 8.2 which means that there is greater variation in private sector university students scores than public sector university students in statistical achievement. The significance (2 tailed) value is 0.205 which is greater than 0.05 means that sector wise, statistically significant difference does not exist in the mean score of statistical achievement. To elaborate the difference further Cohen's D effect size was also calculated, Effect size Cohen's D was found 0.11 which shows small effect size in statistical achievement.

Gender and Sector Interaction Effect on Analysis Data Statistical Thinking and Statistical Achievement

Source	Dependent Variable	Mean Square	F	Sig.
Gander * Sector	Data Analysis Statistical Thinking	176.4	.888	.347
	Statistical Achievement	164.03	2.447	.119
	Formulating Hypotheses	.9	.068	.794
	Designing Studies	46.94	3.952	.048
	Summarizing Data	4.01	.250	.617
	Making Inferences	3.6	.241	.624
	Interpreting Results	12.1	.931	.335

Table Above indicates that the significance value for gender and sector with data analysis statistical thinking (total) is 0.347 which is greater than 0.05 which means that there is no significant effect of gender and sector on students' data analysis statistical thinking. The significance value for gender and sector with statistical achievement is 0.119 which is greater than 0.05 which means that there is no significant effect of gender and sector on student's statistical achievement. The significance value for gender and sector with aspect Formulating Hypotheses is 0.794 which is greater than 0.05 which means that there is no significant effect of gender and sector on Formulating Hypotheses. The significance value for gender and sector with aspect Designing Studies is 0.04 which is less than 0.05 which means that there is significant effect of gender and sector on Designing Studies. The significance value for gender and sector with aspect Summarizing Data is 0.617 which is greater than 0.05 which means that there is no significant effect of gender and sector on Summarizing Data. The significance value for gender and sector with aspect Making Inferences is 0.624 which is greater than 0.05 which means that there is no significant effect of gender and sector on Making Inferences. The

significance value for gender and sector with aspect Interpreting Results is 0.335 which is greater than 0.05 which means that there is no significant effect of gender and sector on Interpreting Results.

Discussion

Average score of students in statistical achievement is 70.55% in compression to 62.14% average score in test of Analyzing data statistical thinking indicates that the students can do well in a routine subject test where procedural knowledge is required but cannot do well when exposed to non-routine assessment involving thinking and reasoning. This fact was evident from mean score of students across different strata where there was greater variance between score in Analyzing data statistical thinking than statistical achievement indicating that good students were doing well in reasoning where weak students were doing worse. In the same way good students were doing well in thinking more than they were doing from their counterparts in sub-scale. Standard deviation of 14.17 in the score of analyzing data statistical thinking shows a large variation in the score of students leading to the fact that the weaker students scored in a low proportion as they did in statistical achievement.

A strong correlation was observed between five aspects (Formulating Hypotheses, Designing Studies, Summarizing Data, Making Inferences, and Interpreting Results) of Analyzing data statistical thinking ranging from 0.656 to 0.852. This was expected because the total score for Analyzing data statistical thinking included each of the five specific abilities. The correlation of five aspects of analyzing data statistical thinking with statistics achievement ranged from 0.41 small correlations to 0.651 medium correlations. The highest correlation among the five aspects of statistical thinking with statistical achievement was Making Inferences followed by Designing Studies. This result clearly showed the importance of these two aspects in statistical achievement and must be included in the curriculum.

The correlation coefficients of the five aspects of analyzing data statistical thinking with the statistical achievement were also positive and statistically significant. There was highest level of correlation between Making Inferences and statistics achievement 0.651 followed by Designing Studies 0.562 with second highest level of correlation.

The comparison of male and female students mean score already discussed shows a significant gender difference in the mean scores of some of aspects of analyzing data statistical thinking and also there is significant difference for the total score of analyzing data statistical thinking. Studies related to the comparison of gender on statistical thinking as a whole shows mixed results. Meta-analysis of gender differences in statistical thinking concludes that male and female statistical thinking is depend upon the type of statistics course, the department offering the course, and how course grades are determined (i.e., exams, writing assignments, and/or homework (Alldredge and Brown 2006; Hilton and Christensen 2002).All private and public sector universities follow the same curriculum set by the Higher Education Commission of Pakistan. The medium of instruction was English in all the public and private universities of Khyber Pakhtunkhwa, Pakistan. The mean score of private sector universities students in analyzing data statistical thinking was 60 and for statistics achievement it was 71 while the mean score of public sector universities students in analyzing data statistical thinking was 64 and for statistical achievement it was 70. Furthermore, male and female students' mean scores in test of all aspects of analyzing data statistical thinking and statistics achievement were compared using t-test. Furthermore, the study investigated the interaction effect of gender and sector on analyzing data statistical thinking and found no statistically significant interaction effect, consistent with Lin's (2012) findings. The study also examined the interaction effect of gender and sector on statistical achievement and found a statistically significant interaction effect, confirming Judge and Bono's (2000) findings.

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