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Assessing Various Dimensions of Statistical Competence among Research Scholars: A Comparative Study

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ABSTRACT

Most of the research studies require knowledge of statistics for the implementation of research results thus in addition to the knowledge of statistical facts the researchers need to acquire statistical reasoning and thinking for making appropriate decision on the use of suitable statistical tool based on the data and for making accurate decision about the rejection and acceptance of the research hypotheses and for drawing accurate, clear and precise conclusions. This study explores the effect of discipline and gender on various dimensions of statistical competence of research scholars of university of Kashmir. For this study quantitative research approach was adopted with paper and pencil survey as research method. Data were collected with the help of questionnaire developed by Punita Govil, Mamum Ali Naji Qasem and Swati Gupta (2015). Two-way ANOVA in the study revealed that discipline of research scholars had a significant effect on understanding of basic statistical concepts, measuring and interpreting the coefficient of correlation, use of various parametric methods, use of various non-parametric methods, explaining the results given by the statistical programs as SAS, SPSS etc., and selecting the appropriate statistical method in accordance with the problem. The study also revealed that gender of research scholars had a significant effect on understanding of basic statistical concepts, measuring and interpreting the coefficient of correlation and selecting the appropriate statistical method in accordance with the problem. However the significant effect of interaction of discipline and gender of research scholars was found only on interpretation of descriptive statistics. Based on these findings, it is recommended that the curriculum at the graduation level should be revised so that the students may have requisite previous knowledge and at post-graduation level learner's knowledge and understanding of statistics should be improved in such a way that when students enter universities they already possess a certain set of statistical skills and abilities.

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Statistical competency is the cognizance of statistical data, knowledge of statistical conceptions, fundamentals of data collection, understanding of descriptive statistics, comprehension of interpretation abilities and communication abilities (Rumsey, 2002). Competency is the behavior and skill that leads to the supreme performance. Statistical competency means knowledge of basic statistics and basic statistics means counting. One of the common definitions of statistics is "it includes maths and relies upon calculation of numbers, how the numbers are selected and how the statistical results are interpreted" (Lane, 2009). Researchers need to possess the knowledge of statistics for appropriately clarifying the distribution of variables and outcomes produced. Knowledge of statistics refers to the knowledge of statistical concepts, statistical methods and statistical ideas. Statistics is used in various aspects of research and research scholars need to have statistical competency for understanding and using statistical concepts and ideas that they encounter at different steps in research and for making fine decisions based on that data. In addition to the knowledge of statistical facts the researchers need to acquire statistical reasoning and thinking for making appropriate decision on the use of suitable statistical tool based on the data and for making accurate decision about the rejection and acceptance of the research hypotheses and for drawing accurate, clear and precise conclusions. Statistics is that charter of research whose guidelines and events if not tracked exactly from the stage of data collection, it would not be possible to draw satisfactory, useable and consistent conclusions. "Statistics is the science and practice of developing human knowledge through the use of empirical data expressed in quantitative form. This discipline is based on sound theories and is branch of applied mathematics" (Govil, et al. 2015). Statistics has an important role in research and competency in statistics acquaints the researcher with knowledge of statistics and develops in them an ability of using statistics in research. Various researchers believe that main reason of conflicting outcomes in the discipline of psychological and educational sciences is due to misuse of statistics and lack of accuracy during analysis of data (Al'Dawsry, 2001; Al'assaf, 1995; cited by Qasem, et al. 2015). It has been revealed that without expertise in statistics, statistical mistakes in published manuscripts are common (Qasem, et al. 2015; Fernandes Taylor, et al., 2011; Mazumdar, et al. 2010; Harris, et al. 2009). So it is imperative for every researcher to acquire statistical competency for coping with rapid developments and quick changes in scientific happenings. Researchers should be capable enough to deal with the statistical programs and handle the statistical aspects of their research. Since the importance of statistics in research is growing, statistics should be included as an important part of the curriculum of course work for developing statistical skills among researchers from the initial stage of their research and for developing an ability in them to analyze the data by applying appropriate statistical methods and techniques. Literature reveals that there is a dearth of studies evaluating the effect of gender and discipline on statistical competency. Current study intends to contribute in this direction and add to the body of knowledge.

LITERATURE REVIEW

Garfield (2003) assessed the statistical reasoning among the students of United States and Taiwan and revealed that students in United States have less reasoning scores and higher misconception scores than students in Taiwan. Females in Taiwan have less reasoning scores and high misconception scores than their male counterparts while in United States reasoning scores were gender neutral but males were found to have lower misconception scores than their female counterparts. Mahmud and Zainol (2008) conducted a study to assess competency of postgraduate students in statistical data analysis and their attitude towards statistics and found that male students possess less positive attitude towards statistics as compared to their female counterparts however no difference in attitude towards statistics was reported on the basis of program of study. The study also revealed that the perceived understanding level percentage was lower than importance level. Coetzee and Vandermerwe (2010) assessed the industrial psychology student's attitude towards statistics and revealed that females and younger students possessed less positive attitude towards statistics than their male counterparts and older students respectively. Mahmud and Osman (2010) conducted a study to investigate the change in student's attitude towards learning elementary statistics and statistical competency after four weeks of statistics course teaching and found that after four weeks of teaching, students showed more positive attitude towards learning statistics and more statistical competency as compared to before teaching. Females showed more positive attitude towards learning statistics and more statistical competency as compared to their male counterparts. Science students showed more positive attitude towards learning statistics and more statistical competency as compared to non-science students. Non-Malay students showed more positive attitude towards learning statistics and more statistical competency as compared to Malay students. Qasem, et al. (2012) constructed a test to measure seven statistical competencies among postgraduate students and found low competency in parametric, non-parametric statistics and use of statistical programs among respondents. Al-Habashneh and Najjar (2017) constructed a test to measure statistical and research competencies among graduate students and found that females and doctorate students possessed more statistical and research competencies as compared to males and MA students respectively.

Aims and objectives of the study

The basic purpose of the study is to assess the effect of discipline, gender and their interaction on various dimensions of statistical competence of research scholars. The following seven hypotheses guided the study:

- Hypothesis 1: There is no significant effect of discipline, gender and their interaction on understanding of basic statistical concepts of research scholars.
- Hypothesis 2: There is no significant effect of discipline, gender and their interaction on interpretation of descriptive statistics of research scholars.
- Hypothesis 3: There is no significant effect of discipline, gender and their interaction on measuring and interpreting the coefficient of correlation of research scholars.

- Hypothesis 4: There is no significant effect of discipline, gender and their interaction on use of various parametric methods of research scholars.
- Hypothesis 5: There is no significant effect of discipline, gender and their interaction on use of various non-parametric methods of research scholars.
- Hypothesis 6: There is no significant effect of discipline, gender and their interaction on explaining the results given by the statistical programs as SAS, SPSS etc. of research scholars.
- Hypothesis 7: There is no significant effect of discipline, gender and their interaction on selecting the appropriate statistical method in accordance with the problem of research scholars.

RESEARCH METHODOLOGY

For this study quantitative research approach was adopted with paper and pencil survey as research method. The research scholars from 3 disciplines of University of Kashmir were used as respondents in the study. The respondents were selected by adopting stratified proportionate random sampling technique. The total population was 1126 research scholars at the 3 disciplines of the surveyed university, while proportional sampling of 50% of study population was used to determine the total sample size of 563 research scholars as respondents in the study. A sample of (59.32% (334)) respondents were from the discipline of science, (28.06% (158)) were from discipline of social science and (12.61% (071)) were from discipline of behavioral science. In terms of gender (51.68% (291)) of the respondents in the study were males and (48.31% (272)) were females. For the purpose of data collection questionnaire developed and standardized by Punita Govil, Mamum Ali Naji Qasem and Swati Gupta (2015) was used. The information blank was prepared by the investigator herself for capturing questions on discipline and gender of respondents as demographic variables. The data was analyzed with the help of SPSS.

RESULTS

Testing of Hypotheses

Hypothesis 1: There is no significant effect of discipline, gender and their interaction on understanding of basic statistical concepts of research scholars.

The hypothesis 1 for the study was tested using 2X3 ANOVA (Table 1). The results revealed that there was significant effect of discipline and gender of research scholars on understanding of basic statistical concepts at the surveyed university. The findings of the post-hoc comparisons in Table 2 reveals that social science and behavioural science research scholars had high understanding of basic statistical concepts than science research scholars at the surveyed university. The findings of the t-test in Table 3 reveals that the female research scholars had high understanding of basic statistical concepts than male research scholars at the surveyed university. Thus, the hypothesis 1 is partially accepted.

Table 1: Main and interactive effect of gender and discipline of research scholars on understanding of basic statistical concepts.

Source of variance	SS	df	MSS	F-value	Sig.
Discipline	1.243	2	.621	18.903*	.000
Gender	.195	1	.195	5.940*	.015
Discipline * Gender	.100	2	.050	1.527	.218
Total	271.562	563			

**Significant at 0.05 level*

Table 2: A Post-Hoc Comparison of the discipline of research scholars on understanding of basic statistical concepts

Mean	SD	N	(I) Discipline	(J) Discipline	Mean Difference (I-J)	Sig.
.706	.197	158	Social Science	Behavioural Science	-.056	.077
				Science	.074*	.000
.762	.173	71	Behavioural Science	Social Science	.056	.077
				Science	.130*	.000
.632	.176	334	Science	Social Science	-.074*	.000
				Behavioural Science	-.130*	.000

**The mean difference is significant at the .05 level.*

Table 3: t-test analysis of understanding of basic statistical concepts of research scholars.

Dimension	Gender	N	Mean	SD	t-value	Sig.
Understanding of Basic Statistical Concept	Female	272	.686	.192	2.133	.033
	Male	291	.652	.182		

Hypothesis 2: There is no significant effect of discipline, gender and their interaction on interpretation of descriptive statistics of research scholars.

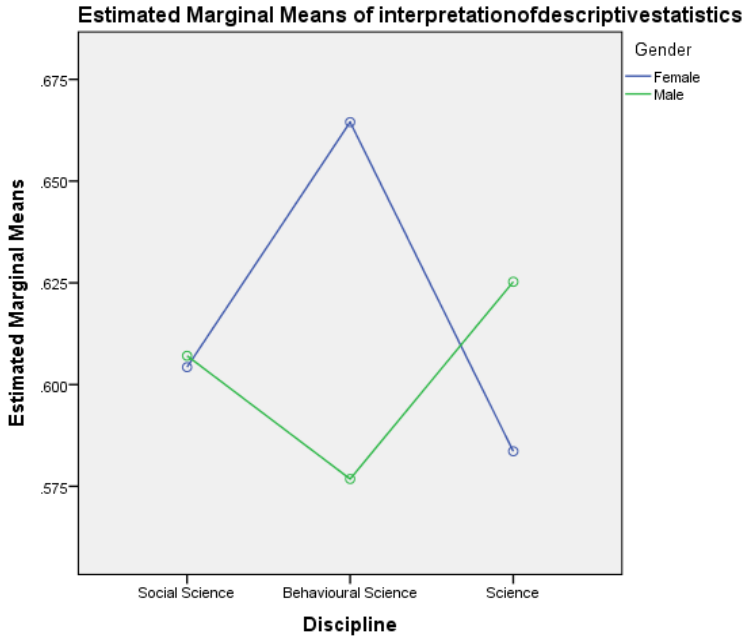
The hypothesis 2 for the study was tested using 2X3 ANOVA (Table 4). The results revealed that there was significant effect of interaction of gender and discipline of research scholars on interpretation of descriptive statistics and no significant main effect of gender and discipline of research scholars on interpretation of descriptive statistics at the surveyed university.

Table 4: Main and interactive effect of gender and discipline of research scholars on Interpretation of Descriptive Statistics.

Source of variance	SS	df	MSS	F-value	Sig.
Discipline	.015	2	.008	.228	.796
Gender	.019	1	.019	.584	.445
Discipline * Gender	.246	2	.123	3.689*	.026
Total	227.182	563			

**Significant at 0.05 level*

Figure 1: Showing the effect of interaction of discipline and gender of research scholars on interpretation of descriptive statistics.



The effect of interaction of gender and discipline on interpretation of descriptive statistics is shown in Figure 1. Which indicates that male research scholars of behavioral science and the female research scholars of science had less competence in interpretation of descriptive statistics than the female research scholars of behavioral science and the male research scholars of science respectively. Moreover, male research scholars of behavioural science also had less competence in interpretation of descriptive statistics than male research scholars of science at the surveyed university. Thus, the hypothesis 2 is partially accepted.

Hypothesis 3: There is no significant effect of discipline, gender and their interaction on measuring and interpreting the coefficient of correlation of research scholars.

The hypothesis 3 for the study was tested using 2X3 ANOVA (Table 5). The results revealed that there was significant effect of discipline and gender of research scholars on measuring and interpreting the coefficient of correlation and no significant effect of interaction of gender and discipline of research scholars on measuring and interpreting the coefficient of correlation at the surveyed university.

Table 5: Main and interactive effect of gender and discipline of research scholars on measuring and interpreting the coefficient of correlation.

Source of variance	SS	df	MSS	F-value	Sig.
Discipline	.675	2	.338	5.914*	.003
Gender	.294	1	.294	5.146*	.024
Discipline * Gender	.226	2	.113	1.981	.139
Total	142.410	563			

** Significant at 0.05 level*

Table 6: A Post-Hoc Comparison of the discipline of research scholars on measuring and interpreting the coefficient of correlation.

Mean	SD	N	(I) Discipline	(J) Discipline	Mean Difference (I-J)	Sig.
.475	.256	158	Social Science	Behavioural Science	-.021	.810
				Science	.061*	.022
.496	.224	71	Behavioural Science	Social Science	.021	.810
				Science	.082*	.023
.414	.235	334	Science	Social Science	-.061*	.022
				Behavioural Science	-.082*	.023

**The mean difference is significant at the .05 level.*

The findings of the post-hoc comparisons in Table 6 reveals that social science and behavioural science research scholars had high competence in measuring and interpreting the coefficient of correlation than science research scholars at the surveyed university. The findings of the t-test in Table 7 reveals that the female research scholars had high competence in measuring and interpreting the coefficient of correlation than male research scholars at the surveyed university. Thus, the hypothesis 3 is partially accepted.

Table 7: t-test analysis of measuring and interpreting the coefficient of correlation of research scholars.

Dimension	Gender	N	Mean	SD	t-value	Sig.
Measuring and interpreting the coefficient of correlation	Female	272	.463	.239	2.041	.042
	Male	291	.421	.244		

Hypothesis 4: There is no significant effect of discipline, gender and their interaction on use of various parametric methods of research scholars.

Table 8: Main and interactive effect of gender and discipline of research scholars on use of various parametric methods.

Source of variance	SS	df	MSS	F-value	Sig.
Discipline	.281	2	.140	3.890*	.021
Gender	.000	1	.000	.004	.951
Discipline * Gender	.002	2	.001	.022	.978
Total	96.306	563			

**Significant at 0.05 level*

Table 9: A Post-Hoc Comparison of the discipline of research scholars on use of various parametric methods.

Mean	SD	N	(I) Discipline	(J) Discipline	Mean Difference (I-J)	Sig.
.361	.204	158	Social Science	Behavioural Science	-.066*	.041
				Science	.003	.983
.427	.206	71	Behavioural Science	Social Science	.066*	.041
				Science	.069*	.016
.358	.178	334	Science	Social Science	-.003	.983
				Behavioural Science	-.069*	.016

**The mean difference is significant at the .05 level.*

The hypothesis 4 for the study was tested using 2X3 ANOVA (Table 8). The results revealed that there was significant effect of discipline of research scholars on use of various parametric methods and no significant effect of gender and interaction of gender and discipline of research scholars on use of various parametric methods at the surveyed university. The findings of the post-hoc comparisons in Table 9 reveals that behavioural science research scholars had high competence in using various parametric methods than science research scholars and social science research scholars at the surveyed university. Thus, the hypothesis 4 is partially accepted.

Hypothesis 5: There is no significant effect of discipline, gender and their interaction on use of various non-parametric methods of research scholars.

The hypothesis 5 for the study was tested using 2X3 ANOVA (Table 10). The results revealed that there was significant effect of discipline of research scholars on use of various non-parametric methods and no significant effect of gender and interaction of gender and discipline of research scholars on use of various non-parametric methods at the surveyed university.

Table 10: Main and interactive effect of gender and discipline of research scholars on use of various non-parametric methods.

Source of variance	SS	df	MSS	F-value	Sig.
Discipline	1.208	2	.604	7.599*	.001
Gender	.289	1	.289	3.640	.057
Discipline * Gender	.061	2	.031	.387	.679
Total	125.320	563			

**Significant at 0.05 level*

Table 11: A Post-Hoc Comparison of the discipline of research scholars on use of various non-parametric methods.

Mean	SD	N	(I) Discipline	(J) Discipline	Mean Difference (I-J)	Sig.
.376	.292	158	Social Science	Behavioural Science	-.126*	.005
				Science	.027	.572
.501	.300	71	Behavioural Science	Social Science	.126*	.005
				Science	.153*	.000
.349	.273	334	Science	Social Science	-.027	.572
				Behavioural Science	-.153*	.000

**The mean difference is significant at the .05 level.*

The findings of the post-hoc comparisons in Table 11 reveals that behavioural science research scholars had high competence in using various non-parametric methods than science research scholars and social science research scholars at the surveyed university. Thus, the hypothesis 5 is partially accepted.

Hypothesis 6: There is no significant effect of discipline, gender and their interaction on explaining the results given by the statistical programs as SAS, SPSS etc. of research scholars.

The hypothesis 6 for the study was tested using 2X3 ANOVA (Table 12). The results revealed that there was significant effect of discipline of research scholars on explaining the results given by

different statistical programs and no significant effect of gender and interaction of gender and discipline of research scholars on explaining the results given by different statistical programs at the surveyed university.

Table 12: Main and interactive effect of gender and discipline of research scholars on explaining the results given by the statistical programs as SAS, SPSS etc.

Source of variance	SS	df	MSS	F-value	Sig.
Discipline	.275	2	.137	3.770*	.024
Gender	.076	1	.076	2.081	.150
Discipline * Gender	.007	2	.003	.094	.911
Total	86.375	563			

**Significant at 0.05 level*

Table 13: A Post-Hoc Comparison of the discipline of research scholars on explaining the results given by the statistical programs as SAS, SPSS etc.

Mean	SD	N	(I) Discipline	(J) Discipline	Mean Difference (I-J)	Sig.
.376	.292	158	Social Science	Behavioural Science	-.126*	.005
				Science	.027	.572
.501	.300	71	Behavioural Science	Social Science	.126*	.005
				Science	.153*	.000
.349	.273	334	Science	Social Science	-.027	.572
				Behavioural Science	-.153*	.000

** The mean difference is significant at the .05 level.*

The findings of the post-hoc comparisons in Table 13 reveals that behavioural science research scholars had high competence in explaining the results given by the different statistical programs than science research scholars and social science research scholars at the surveyed university. Thus the hypothesis 5 is partially accepted.

Hypothesis 7: There is no significant effect of discipline, gender and their interaction on selecting the appropriate statistical method in accordance with the problem of research scholars.

The hypothesis 7 for the study was tested using 2X3 ANOVA (Table 14). The results revealed that there was significant effect of discipline and gender of research scholars on selecting the appropriate statistical method in accordance with the problem at the surveyed university.

Table 14: Main and interactive effect of gender and discipline of research scholars on selecting the appropriate statistical method in accordance with the problem.

Source of variance	SS	df	MSS	F-value	Sig.
Discipline	1.517	2	.759	15.301*	.000
Gender	.193	1	.193	3.897*	.049
Discipline * Gender	.068	2	.034	.683	.506
Total	120.278	563			

**Significant at 0.05 level*

Table 15: A Post-Hoc Comparison of the discipline of research scholars on selecting the appropriate statistical method in accordance with the problem.

Mean	SD	N	(I) Discipline	(J) Discipline	Mean Difference (I-J)	Sig.
.389	.214	158	Social Science	Behavioural Science	-.158*	.000
				Science	.013	.818
.547	.248	71	Behavioural Science	Social Science	.158*	.000
				Science	.171*	.000
.376	.221	334	Science	Social Science	-.013	.818
				Behavioural Science	-.171*	.000

**. The mean difference is significant at the .05 level.*

Table 16: t-test analysis of selecting the appropriate statistical method in accordance with the problem of research scholars

Dimension	Gender	N	Mean	SD	t-value	Sig.
Selecting the appropriate statistical method in accordance with the problem	Female	272	.422	.230	2.021	.044
	Male	291	.383	.228		

The findings of the post-hoc comparisons in Table 15 reveals that behavioural science research scholars had high competence in selecting the appropriate statistical method in accordance with the problem than science and social science research scholars at the surveyed university. The findings of the t-test in Table 16 reveals that the female research scholars had high competence in selecting the appropriate statistical method in accordance with the problem than male research scholars at the surveyed university. Thus, the hypothesis 7 is partially accepted.

DISCUSSION

The knowledge and competency in statistics is very important for all those students who are desirous to get admission in M.Phil, P.hD courses or who want to apply for fellowship programs. Most of the researches require understanding of statistics for the implementation of the research

results. The present study explores the effect of discipline and gender and their interaction on various dimensions of statistical competence of research scholars. Statistical competency of research scholars enhances the quality of research output in academics. Thus, the present study stresses the necessity to upgrade and reform the curriculum at the graduation level so that students may have requisite previous knowledge. There is the necessity to make extra provisions for learners at post-graduation level also so that their knowledge and understanding of statistics may be improved and when students enter universities, they already possess a certain set of statistical skills and abilities wherein the supervisors have to uphold and upgrade the level of knowledge and understanding of statistics. Since the importance of statistics in research is growing, statistics should also be included as an important part of the curriculum of course work for developing statistical skills among researchers from the initial stage of their research and for developing an ability in them to analyze the data by applying appropriate statistical methods and techniques.

CONCLUSION

The study has resulted in the following conclusions:

1) Social science and behavioural science research scholars had high understanding of basic statistical concepts than science research scholars and the female research scholars had high understanding of basic statistical concepts than male research scholars at the surveyed university.
2) The competency in the interpretation of descriptive statistics of female research scholar's increase as the discipline changes from science to behavioral science and decreases as the discipline changes from behavioral science to social science. While as in case of male research scholar's competency in the interpretation of descriptive statistics decrease as the discipline changes from science to behavioral science and increases as the discipline changes from behavioral science to social science. Male research scholars of behavioral science had less competence in interpretation of descriptive statistics than the female research scholars of behavioral science and the female research scholars of science had less competence in interpretation of descriptive statistics than the male research scholars of science. Moreover male research scholars of behavioural science had less competence in interpretation of descriptive statistics than male research scholars of science discipline at the surveyed university.
3) Social science and behavioural science research scholars had high competence in measuring and interpreting the coefficient of correlation than science research scholars and the female research scholars' had high competence in measuring and interpreting the coefficient of correlation than male research scholars at the surveyed university.
4) Behavioural science research scholars had high competence in using various parametric methods than science research scholars and social science research scholars at the surveyed university.

5) Behavioural science research scholars had high competence in using various non-parametric methods than science research scholars and social science research scholars at the surveyed university.
6) Behavioural science research scholars had high competence in explaining the results given by the different statistical programs than science research scholars and social science research scholars at the surveyed university.
7) Behavioural science research scholars had high competence in selecting the appropriate statistical method in accordance with the problem than science and social science research scholars and the female research scholars had high competence in selecting the appropriate statistical method in accordance with the problem than male research scholars at the surveyed university.

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Conflict of Interest

The author(s) declared no conflict of interest with respect to the research, authorship, and publication of this article.

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