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SHORTCOMINGS IN THE APPLICATION OF STATISTICAL METHODS FOR UNDERGRADUATE, POSTGRADUATE AND DOCTORAL STUDENTS

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ABSTRACT

This paper will study and analyse the content of the statistics curriculum for the high school (the 11 and 12 year) for the scientific and literary sections. This paper studied the existing problem represented in the apparent void in the scientific and academic content of the statistics curricula for the secondary stage, and the great void between those curricula and the modern and advanced statistical applications and programs applied in undergraduate and graduate studies. The paper also provides developments to improve the scientific for the curricula of statistics for the secondary stage in the Libyan state, in line with the advanced statistical applications and methods applied in undergraduate and graduate studies. The researcher relied on the simple layer random sampling method in order to achieve justice in the selection and to involve all disciplines in proportions that correspond to the preparation of the graduate and meticulous student community in all disciplines and scientific branches. The study sample selected in a random manner from the total Libyan undergraduate, postgraduate and doctoral students studying in the United Kingdom during the period from 2010 to 2020 and who benefited from the services provided by the Aseel Memorial Research Centre (AMRC).

Key words: Shortcomings, Statistics Curriculum, Undergraduate, Graduate and Doctoral students,High schooland Statistical methods.

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Introduction

Statistics is the grammar of Science," a famous quote by Karl Pearson the British statistician and leading founder of the modern field of statistics. (Goksel, 2018). The Oxford Dictionary of Statistical Terms [Dodge, 2006] defines statistics as the study of data collection, analysis, interpretation, presentation, and organisation. The science of learning from data is known as statistics. In other words, statistics is the tool we use to turn data into knowledge. (Goksel, 2018). Statistical thinking will one day be as important as reading and writing skills and qualifications for effective citizenship. — Samuel Wilkes, 1951, paraphrasing H. G. Wells from Mankind in the Making (Joseph C W. (). An Introduction to the Science of Statistics: From Theory to Implementation). Statistics is a fundamental information that provides a structured and cogent mathematical framework for all data analysis tasks (Cobb and David 1997). The science of learning from data is known as statistics. statistical abilities aids in the collection of data, the application of reliable analyses, and the efficient presentation of results. statistics is an important part of how we make scientific discoveries, make data-driven decisions, and make forecasts. statistics assist you to gain a better understanding of a subject. frost is a fictional character (2018). This section of the paper provides a rapid summary of historical advancements in statistic statistics theory and applications, from 1600 AD to the beginning of the twentieth century, when the foundations of present statistics were set, as well as some significant contributions in the field of statistics. According to Gupta, Mandal, and Parsad (2017), John Graunt founded the first English school between 1620 - 1674, which was considerably closer to the present concept of statistics. Thomas Bayes introduced Bayes' Theorem in 1701-1761. Gottfried Achenwall is credited with being one of the first to identify the term "statistics" (1719–1772). Carl Friedrich Gauss (1777–

1855) proposed a bell-shaped or "normal" curve that peaks around the mean value and rapidly falls down towards plus/minus infinity. AdolpheQuetelet established the science of probability and statistics, which was mostly used in astronomy from 1796 to 1874. Francis Galton Galton (1822– 1911) used regression and correlation to study genetic diversity in people. Charles Edward Spearman (1863–1955) was a pioneer in the field of factor analysis and Spearman's rank correlation coefficient. William Sealy Gosset, who wrote under the pen name Student and invented the t-distribution, lived from 1876 until 1937. Kirstine Smith Smith (1878–1939) invented the minimal chi-squared estimation of the correlation coefficient. Maurice George Kendall is credited with inventing the Kendall Tau rank correlation coefficient, which is named after him. Wolfowitz (1910–1981) The subjects of statistical decision theory, nonparametric statistics, sequential analysis, and information theory were among Wolfowitz's significant contributions. John Tukey was a mathematician who invented the Tukey lambda distribution, the Tukey's test of additivity, and the Teichmüller–Tukey lemma. He lived from 1915 until 2000.From 1919 to 2005, In cooperation with W. Allen Wallis, William Kruskal created the widely used non-parametric test Kruskal–Wallis oneway analysis of variance. 1920; Rao CalyampudiRadhakrishna contributed to multivariate analysis, Rao's canonical factor analysis, estimation theory, and differential geometry, Analysis of Diversity (ANODIV) as a generalisation of ANOVA, and Rao's canonical factor analysis. Sir David Roxbee Cox D R Cox, contributions to experimental design and binary data analysis, 1924. He is the inventor of the Cox point process, often known as a doubly stochastic Poisson process or mixed Poisson process. Jayanta K Ghosh was born in the year 1937. JayantaGhosh has made significant contributions to Bayesian inference, Bayesian non-parametric, asymptotic, modelling and model selection, invariance in testing and estimation, high-dimensional data analysis, non-parametric regression and density estimation, survival analysis, statistical genetics, multiple testing, and the mixture model.

2.0 Theoretical statistics

2.1 The importance of statistics

Before any explanation has been established, statistics' purpose is to find and quantify key effects and correlations, and one of the most popular ways to do so is to utilise empirical data to reject a "null hypothesis" that there is no relationship or no impact. Descriptive statistics are a valuable tool for summarising data that already exists. Inferential statistics, on the other hand, concentrates on data patterns and then makes inferences from them. To effectively analyse data, statistical inference is required. To assess study findings and develop relevant conclusions, competent data analysis is required (Laake, Benestad and Olsen 2015). By measuring the element of chance or uncertainty, statistics aids decision-making. It is descriptive and inferential responsibilities not only lay the foundation for practically all of today's disciplines, but they also open up a slew of non-traditional job opportunities, from sports analysts to business analysts (University Grants Commission, 2015).

2.2 Relationship of the statistics with scientific fields

There is hardly any human activity that does not need the use of statistics in our everyday lives. As a result, statistics is used extensively in almost every field, including mathematics, physics, chemistry, biology, botany, medicine, economics, education, public policy, psychology, astronomy, zoology, biotechnology, information technology, manufacturing, service industry, business, and commerce (Goksel, 2018).The study of social phenomena, particularly human behaviour in a social setting, is the subject of social statistics, a branch of statistical science. Any type of human activity, including actions of groups of people such as homes, societies, and nations, and their effects on culture, education, and other fields, is considered a phenomenon (Mara, 2019). Because of the nature of social sciences, it is typical to look at indicators that cannot be directly assessed. Furthermore, unobservable, informal, illegal, or "too personal" data is frequently investigated in this field (Lovric, 2011).Statistical approaches have been used extensively in the subject of education, primarily in education measurement. This article contains brief definitions of numerous statistical subjects that have found applications in education, as well as instances of how some of these topics have been used in education (Sinharay, 2010).

2.3 The importance and purpose of the study

The importance of the study lies mainly in presenting the problem in its true face and revealing all its negative aspects before decision makers in the centres of scientific curricula. In addition to trying to reveal the obstacles and problems behind the failure of the application process of the theory with regard to statistical methods. The paper aims mainly to envision an ideal model for the statistics curriculum for the high school in the scientific and literary sections that is scientifically and academically compatible with the practical and advanced scientific applications and is in line with the developments and statistical programs in the field of statistical analysis and statistical methods.The originality of the current research is the point of view, which analyses the challenges that Greek senior high school students from Experimental and Private high schools identify in learning and teaching statistics. The current study aims to pinpoint these issues from the perspective of the pupils.

2.4 Problem of study

The problem of the study mainly lies in the inefficiency and quality of the curricula prescribed for the high school in Libyan schools in the literary and scientific sections.The problems are initially represented in placing statistics as an additional subject and giving it the least number of academic hours for students. In addition, the curricula for high school lack the scientific and practical realism of statistical analysis. Also, the current courses are far from scientific development and far from keeping pace with the development in modern statistical programs, applications, and statistical tests adopted in data analysis. In addition, 80% of the subjects scheduled for high school for the scientific department are considered sterile and their practice ends at the end of the student's academic year. It is possible to refer to the differences and differences in the language and statistical symbols written in both the statistics book for the high school education for the scientific section as well as the literary section. Therefore, state that one of the most interesting fields in which the methodology of teaching Statistics must focus is in depth analysis of the difficulties that students face in understanding statistical concepts and the stochastic way of thinking, as well as, the factors that are responsible for this fact (Garfield and Ahlgren,1988).

3.0 Methodology

Many previous studies have adopted the quantitative method to achieve the goals by applying questionnaires as the primary means of data collection. The current paper used quantitative research, based on questionnaire survey to elicit specific perspectives, cognitive dimensions, and the viewpoints on the studying the statistics course in the Libyan state for the secondary in the scientific and literary sections and statistical applications as well as data analysis during undergraduate, postgraduate and doctoral studies. Moreover, the current paper analysed the content of the statistics curriculum for the high school (the 11 and 12 year) for the scientific and literary sections, through focusing on the great gap between theory and practice in statistical methods. This paper studied the existing problem represented in the apparent void in the scientific and academic content of the statistics curricula for the secondary stage, and the great void between those curricula and the modern and advanced statistical applications and programs applied in undergraduate and graduate. The current paper also developed an advanced scientific proposal for the curricula of statistics for the secondary stage in the Libyan state, in line with the advanced statistical applications and methods applied in undergraduate and graduate studies.

3.1 Questionnaire Guide

The questionnaire has been designed to be suitable, for undergraduate, postgraduate and doctoral students in various UK scientific and social disciplines. The questionnaire consists of 4 main questions designed on the Likert scale method for ease of obtaining answers and responses and the possibility of applying descriptive and inferential statistical tests to achieve the main goal of the paper.

1. To what extent were you satisfied with the curriculum of statistics of high school?
2. To what extent do you agree that the statistics curriculum for high school is compatible with the requirements of postgraduate research?
3. To what extent do you think the inadequacy of the high school statistics curriculum was the main reason for your inability to complete the statistical analyses required to complete your academic research?

4. To what extent do you think it is necessary to make changes and develop the curricula of statistics high school?

These four questions were directed to the members of the sample, that considering that all of them had faced scientific difficulties that prevented them from completing their academic research without the help of research centres, including the Aseel Memorial Research Centre (AMRC). In the first phase of this study, data was collected in part by posting an online questionnaire based on Microsoft Teams to each study participant and they were provided with direct contact details of the researcher.

3.2 Data collected

The researcher relied on the simple layer random sampling method in order to achieve justice in the selection and to involve all disciplines in proportions that correspond to the preparation of the graduate and meticulous student community in all disciplines and scientific branches. The study sample was selected in a random manner from the total Libyan undergraduate, postgraduate and doctoral students studying in the United Kingdom during the period from 2010 to 2020 and who benefited from the services provided by the Aseel Memorial Research Centre (AMRC) using the snowball sampling, a recruitment tool that enhances participant relationships to reach a particular population group (Thompson, 1997). The number of the sample was 91 Libyan students studying in UK universities in all fields of study, including applied and humanitarian.

4.0 Results

According to previous studies, descriptive analysis or exploratory data analysis usually does not make any random assumptions (Maravillakis, 2019) and therefore the first step was to apply Cronbach alpha test. It has been applied to determine the reliability of the questionnaire where the value was 0.83. In this case, α =0 .83, which showed the questionnaire is reliable. The second step was analysing the data by applying the tests descriptive statistics: arithmetic mean, standard deviation and Likert scale to provide a description of the data and try to determine what kind of Abnormal attitudes, relationships, or behaviour. In addition, to test the statistical significance, a one-sample t-test was applied at a confidence level of 95% has been applied.

The Table 1 below shows that 47 students (51%) of the sample members (postgraduate students participating in the study) were from the humanities (literary section), distributed among all scientific branches; psychology, sociology, management, economics, accounting, law, history, linguistics, religious studies, educational studies and media. The data also indicates that 44 students (49%) of the sample members (postgraduate students participating in the study) were from applied sciences (scientific department), distributed among all scientific branches; medicine, engineering, biology, physics, chemistry, mathematics, geography, earth sciences, environmental sciences, pharmacy and agricultural sciences. This is in addition to the fact that 53% of the respondents are postgraduate students (Masters), while 47% are micro-studies (PhD) students(Table 1).

Table 1: Number of samples and scientific branches

Humanities (Social)	Number of students	Applied Sciences	Number of students
Psychology	3	Medical	3
Sociology	4	Engineering	6
Administration	10	Biology	3
Economy	2	Physics	3
Accounting	4	Mathematics	2
Law	2	Geography	5
History	2	Earth science	8
Linguistics	4	Environmental Sciences	6
Religious Studies	2	Chemistry	3
Educational studies	9	Pharmacy	2
Media	5	Agricultural Sciences	3

4.1 Satisfaction with the statistics curriculum for the high school

In this section, the researcher attempts to analyse the data collected related to satisfaction with the statistics curriculum for the high school in both the scientific and literary classes. In this section, the study tests the first hypothesis, which states that;

There is no statistically significant evidence of dissatisfaction of undergraduate, graduate and doctoral students with the statistics curriculum for the high school

$$HO: \mu \leq 3$$

$$HA: \mu > 3$$

To test this hypothesis, the participants were asked to what extent they agree that they felt satisfied with the curriculum of statistics of the high school. The mean of agreement in response to this question is found to be 1.80 with a slightly low standard deviation of 0.987. The percentage of the participants who responded to this question as "strongly disagree" and "disagree" was 84.6%

of the total participants who responded to the questionnaire survey. The percentage of participants who rated this statement as “strongly agree” and “agree” were less than 10.0% of the total participants who responded to the questionnaire survey. According to the Likert Scale Interpretation, the mean value ranges between 1.8 and less than 2.59, suggesting that the agreement of satisfaction with the statistics curriculum for the high school is low (Table 2).

Table 2: The percentages of respondents to the statements that relevant to the” statistics curriculum for high school” with average and standard deviation

	Average	Standard Deviation	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
			%				
To what extent do you satisfied with the curriculum of statistics of the high school?	**1.80**	**0.987**	**25.3**	**59.3**	**5.5**	**7.7**	**2.2**

The t-test result shows that t critical (1.701) is less than t statistic (2.576) and the P-value is 0.002 (Table 3) which is less than Alpha value (0.05) therefore, we reject HO and we accept the alternative hypothesis H1 and can confirm that:

There is statistically significant evidence of dissatisfaction of undergraduate, graduate and doctoral students with the secondary school statistics curriculum.

Accordingly, it is clear that the postgraduate students are not satisfied with the statistics curriculum of the secondary stage.

Table 3: One-sample t- test values

	Curriculum of statistics
Mean	1.801
Variance	0.974
Observations	91
Pearson Correlation	0.231
Hypothesized Mean	3
df	90
t Stat	2.576
P(T<=t) one-tail	0.00012
t Critical one-tail	1.701
P(T<=t) two-tail	0.0064
t Critical two-tail	2.048

4.2 The compatibility of the statistics curriculum with requirements of postgraduate.

In this section, the researcher attempts to analyse the data collected related to compatibility of the statistics curriculum for the high school with the requirements of postgraduate research. In this section, the study tests the first hypothesis, which states that:

There is a statistical indication that the statistics curricula are compatible with the requirements of postgraduate studies.

$$HO: \mu \leq 3$$
$$HA: \mu > 3$$

To test this hypothesis, the participants were asked to what extent do you agree that the statistics curriculum for the high school is compatible with the requirements of postgraduate research? The mean of agreement in response to this question is 2.00 with slightly higher standard deviation of 1.048. The percentage of the participants who responded to this question as "strongly disagree" and “disagree” was 86.9% of the total participants who responded questionnaire survey (Table 4). The percentage of participants who rated this statement as both of strongly agree” and “agree” was lower percentage with less than 9.0% of the total participants who responded to the questionnaire survey.

Table 4: The percentages of respondents to the statements that relevant to the” statistics curriculum for high school” with average and standard deviation

	Average	Standard Deviation	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
			%				
To what extent do you agree that the statistics curriculum for high school is compatible with the requirements of postgraduate research?	2.0	1.048	37.4	49.5	4.4	5.5	3.3

According to the Likert Scale Interpretation, the mean value ranges between (1.80 and less than 2.59), suggesting that the agreement of satisfaction with the statistics curriculum for high school is low.

The t-test result shows that t critical (1.419) is less than t statistic (2.230) and the P-value is 0.002 (Table 3) which is less than Alpha value (0.05) therefore, we reject HO and we accept the alternative hypothesis H1 and can confirm that:

There is no statistical evidence of compatibility of the statistics curricula with the requirements of postgraduate studies.

Accordingly, it turns out that the statistics curriculum for the secondary stage is not compatible with the requirements of graduate studies.

Table 5: One-sample t- test values

	The requirements of postgraduate research
Mean	**2.00**
Variance	**1.084**
Observations	**91**
Pearson Correlation	**0. 12481**
Hypothesized Mean Difference	**3**
df	**90**
t Stat	**2.230**
P(T<=t) one-tail	**0.00012**
t Critical one-tail	**1.419**
P(T<=t) two-tail	**0.0064**
t Critical two-tail	**2.011**

4.3 The student's ability to perform statistical analysis and the secondary school statistics curricula

In this section, the researcher attempts to analyse the data collected related the student's inability to take statistical tests and the statistics curriculum at the secondary stage. In this section, the study tests the third hypothesis, which states:

There is a statistical indication of the student's ability to perform and complete the statistical tests required for postgraduate studies.

$$HO: \mu \leq 3$$
$$HA: \mu > 3$$

To test this hypothesis, the participants were asked to what extent do you agree that the inadequacy of the high school statistics curriculum was the main reason for your inability to complete the statistical analyses required to complete your academic research.

The mean of agreement in response to this question is relatively high of 3.85 with the highest standard deviation of 1.314. The percentage of the participants who responded to this question as "strongly agree" and "agree" was 88.6% of the total participants who responded questionnaire survey. The percentage of participants who rated this statement as both of strongly disagree" and "disagree" was lower percentage with 9.1% of the total participants who responded to the questionnaire survey.

Table 6: The percentages of respondents to the statements that relevant to the" statistics curriculum for high school" with average and standard deviation

	Average	Standard Deviation	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
			%				
To what extent do you agree that the inadequacy of the high school statistics curriculum was the main reason for your inability to complete the statistical analyses required to complete your academic research?	**3.8**	**1.314**	**4.4**	**4.7**	**3.3**	**48.3**	**40.3**

According to the Likert Scale Interpretation, the mean value ranges between (3.40 and less than 4.19), suggesting that the agreement of satisfaction with the statistics curriculum for high school is high.

The t-test result shows that t critical (1.640) is less than t statistic (2.444) and the P-value is 0.002 (Table 3) which is less than Alpha value (0.05) therefore, we reject HO and we accept the alternative hypothesis H1 and can confirm that:

There is no statistical indication of the student's ability to perform and complete the statistical tests required for postgraduate studies.

Accordingly, it is clear that the postgraduate students are unable to carry out statistical analysis operations and complete the requirements of postgraduate studies in terms of collecting and analysing data and interpreting the results.

Table 7: One-sample t- test values

	Inadequacy of the high school
Mean	**3.85**
Variance	**1.314**
Observations	**91**
Pearson Correlation	**0.17453**
Hypothesized Mean Difference	**3**
df	**90**
t Stat	**2.444**
P(T<=t) one-tail	**0.00078**
t Critical one-tail	**1.640**
P(T<=t) two-tail	**0.0012**
t Critical two-tail	**2.135**

4.4 The necessity of making changes and developing the statistical curricula for the secondary stage.

In this section, the researcher attempts to analyses the data collected related to the necessity of making changes and developing statistical curricula for the secondary stage. In this section, the study tests the third hypothesis, which states:

There is a statistical indication that changes and development of the statistics curriculum for the secondary stage are not necessary.

$$HO: \mu \leq 3$$
$$HA: \mu > 3$$

The mean agreement in response to this question is found relatively to be 3.70 with slightly lower standard deviation of 1.285. The percentage of the participants who responded to this statement as "strongly agree" and "agree" was high of 91.2% of the total participants who responded questionnaire survey. The percentage of participants who rated this statement as both of strongly disagree" and "disagree" was lower percentage with less than 9.0% of the total participants who responded to the questionnaire survey.

Table 8: The percentages of respondents to the statements that relevant to the" statistics curriculum for high school" with average and standard deviation.

According to the Likert Scale Interpretation, the mean value ranges between (3.40and less than 4.19), suggesting that the agreement of satisfaction with the statistics curriculum for high school is high

	Average	Standard Deviation	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
			%				
To what extent do you agree that it is necessary to make changes and develop the curricula of statistics for the secondary stage?	**3.7**	**1.285**	**2.2**	**3.3**	**3.3**	**48.3**	**42.9**

The t-test result shows that t critical (1.566) is less than t statistic (2.318) and the P-value is 0.002 (Table 3) which is less than Alpha value (0.05) therefore, we reject HO and we accept the alternative hypothesis H1 and can confirm that:

There is no statistical indication that changes and development of secondary school statistics curricula are not necessary

Accordingly, it is clear that the curriculum for statistics for the secondary stage needs to be developed in line with the requirements of graduate studies

Table 9: One sample t-test values

	changes and develop the curricula of statistics
Mean	**3.70**
Variance	**1.285**
Observations	**91**
Pearson Correlation	**0.1374**
Hypothesized Mean Difference	**3**
df	**90**
t Stat	**2.318**
P(T<=t) one-tail	**0.0012**

t Critical one-tail	**1.566**
P(T<=t) two-tail	**0.0044**
t Critical two-tail	**1.923**

5.0 Discussion

Through the results obtained related to the four statements raised in the paper:

Satisfaction with the statistics curriculum for high school.It is clear that the postgraduate students are not satisfied with the statistics curriculum of the secondary stage.

2- The compatibility of the statistics curriculum with requirements of postgraduate.

It turns out that the statistics curriculum for the secondary stage is not compatible with the requirements of graduate studies.

3- The student's ability to perform statistical analysis and the secondary school statistics curricula.It is clear that the postgraduate students are unable to carry out statistical analysis operations and complete the requirements of postgraduate studies in terms of collecting and analysing data and interpreting the results.

4- The necessity of making changes and developing the statistical curricula for the secondary stage.It is clear that the curriculum for statistics for the secondary stage needs to be developed in line with the requirements of graduate studies At the outset, it can be noted that there is a state of dissatisfaction among graduate students in all fields of study with the statistics curricula at the secondary level.This is a result of their inability to conduct statistical analysis and complete the requirements of the study with regard to methods of information collection and statistical analysis and the application of appropriate statistical tests for their study.It can also be referred to what has been verified that the statistics curricula for the secondary stage do not correspond to a large extent with the requirements of postgraduate studies.This was represented in the great void between the subjects studied in the secondary stage in statistics and what they had to do in terms of tests and statistical analysis to complete the requirements of the study. In addition, the results showed that postgraduate students were not able to conduct statistical analysis and complete the requirements of postgraduate studies in terms of collecting and analysing data and interpreting the results. This can be attributed to the primitiveness of most of the subjects taught in statistics for the secondary stage and their lack of keeping pace with the advanced science of statistics.It can also be noted that the statistics curricula for the secondary stage are primitive and do not keep pace with scientific developments in the processes of collecting and analysing evidence and applying statistical tests through modern statistical programs such asMicrosoft Excel, Minitab Statistical Software, Statistical Package for the Social Sciences SPSS software package and the R Project for Statistical Computing.

Recommendations

According to the results of the paper, the researcher advices:

The need to make changes and develop the curricula prescribed in statistics for the secondary stage in line with the requirements of modern graduate studies.

Developing the statistics curriculum through improving the quality of the units taught by adding things such as SPSS and Excel

Improving the current teaching strategies and methods for the curriculum through

Providing more lesson time in the subject and teaching statistics throughout 3 years of high school rather than 2 (year 10,11 and 12)

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