

Using Free Websites to Perform Statistical Calculations in Basic Statistics Courses at High School or College Levels

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1. Abstract

A basic course in statistics at the high school or college level will expose students to numerous varieties of statistics and statistical tests. Some students may not be able to afford expensive graphing calculators or laptop computers with commercial statistical software packages installed. An alternative, free option is the use of statistical programs available on the internet. A chart is provided of several programs that can be used for each of several types of statistical problems. Even though such programs will probably change, with old ones disappearing and new ones replacing them, the chart provides a useful template that can be updated as needed by those who teach basic statistics classes.

2. Keywords: Statistics, Education, Statistical websites, Calculations

3. Introduction

When teaching statistics at a basic level at the high school level or the college level, there are many important considerations. One opportunity to consider is the use of real-world historical events for

examples in class [1, 2]. Another opportunity would be a way to simplify the organization of probability formulae so selecting the correct formula for any given problem is easier for students to understand [3]. A third opportunity is to discuss the ways in which statistics can be used to help resolve or at least better understand issues of considerable controversy [4]. A fourth opportunity is for students to identify statistical errors in published, peer-reviewed journal articles [5, 6], which can be used as an applied method of assessing student learning. A fifth opportunity might be to challenge formulae presented in textbooks – are they optimal? [7]. A final opportunity might be to compare the means and standard deviation from two or more subgroups presented in one journal article [8] to their sum presented in a different journal article [9]

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Received Date: April 27, 2021; Accepted Date: April 28, 2021;

Published Date: May 13, 2021

– and see if they match up (internalizing and externalizing measures). A class also might review basic statistical procedures and their importance [10, 11] and how they are or are not being applied well within a given area of science [12]. However, requirements not only for tuition and transportation but for the often required purchase of expensive graphing calculators may put statistical education beyond the financial reach of many potential students. While performing calculations by hand can be a useful learning tool for a better understanding of the processes involved in statistical calculations, after graduation most professionals will rely upon statistical packages or other resources to provide for greater accuracy in such calculations. One method that we have used for several years is to provide students with free websites that will perform most of the calculations required in a basic statistics class as the high school or college level. Even if students cannot afford the purchase of their own laptop or statistical packages, the internet can often be accessed at no cost at public WIFI sites, such as public libraries, using free public computers. Some students may have their own cellphones that may allow access to the web.

4. Methods

The basic statistics considered were derived from an introductory textbook [13]. Each type of statistics, associated in most cases with a specific chapter from [13], was set in a specific row in Figure A. We used columns in the figure/chart to identify the statistic, the chapter, several websites for that statistic or statistical calculation, and miscellaneous remarks.

5. Product

The chapters mentioned in Figure A are from an introductory statistics textbook [13].

In figure A, there are four columns. The first column identifies the statistic and the second column mentions the chapter in Brase and Brase [13] that discusses the statistics. The third column mentions some websites that will permit calculation of statistics

at no cost to the user/student. The fourth column contains remarks. Some websites will allow the entry of raw data before calculation of the statistic, others will only need summary data, while some will permit use of both. The list of websites is far from inclusive of all available sites but should provide students (or faculty) with a sufficient number. Some of the listed websites allow for calculation of other statistics as well as those in the given row of Figure A, but we didn't want to repeat the same site more than a few times at most.

6. Limitations

Websites may change over time, even eliminated. New websites can be created. Therefore, the life span of Figure A may be limited. Even so, it may provide a template for being updated with new website information. The websites usually are written in English, so the material may be of less usefulness to non-English readers. We did not attempt to list websites that would permit graphing of histograms, pie charts, dot plots, bar charts, ogives, time series graphs, box and whisker charts, scattergrams, or regression lines, but others may want to follow up this report with similar information on those matters.

7. Discussion

Some statistics (e.g., t-tests, effect sizes) may be calculated from summary information: means, standard deviations or standard errors, and group/subgroup sample sizes. Not only will summary information be available in examples from textbooks, but it will be available in many published journal articles, information that can be checked by students. Students may find that in some cases, statistical results that are deemed “profound” in terms of rejection of the null hypothesis may not have been statistically significant (i.e., not justifying rejection of the null hypothesis); in other cases, results deemed of no importance may have been, at least statistically, significant even if effect sizes were low [14]. In some cases, mathematically impossible statistics have been reported, suggesting possible fabrication of research

[15, 16]. The SPRITE program is a free software program that can help determine if mean scores and/or standard deviations are legitimate or not [17]. In other cases F tests may not have been reported properly, as well as other errors [5]. Figure A is not all inclusive; there are many other sources of online statistical calculators, but here several are presented as illustrations of what is available for students and other professionals needing a way to calculate basic statistics.

Students may enjoy the opportunity to publish papers with their instructor when flaws or errors in statistics in published reports are detected.

8. Conclusion

Students from all income levels may have a better chance to access statistical calculators through free websites on the internet than from the purchase of expensive graphing calculators, laptops, or statistical

software packages. Figure 1 provides an introductory list of many of the available websites for each of several types of statistics or statistical calculators. Instructors of basic statistical courses may use Figure 1 to encourage their students' success and access to relevant statistics; possibilities may occur for co-publishing of critiques of published articles that contain important statistical errors or misleading use of statistics.

Conflicts of Interest: None (Dr. Schumm was on phased retirement, 25% time, as of Spring 2021, so there was no conflict with teaching at Highland Community College, Wamego Campus).

Acknowledgements: Carol White, Head of the Math Department, Highland Community College, Wamego Campus, reviewed a preliminary version of Figure A.

Statistic	Chapters in Brase and Brase	Websites	Remarks
Means, SD, SE, Median, Mode	Chapter 3	https://www.calculatorsoup.com/calculators/statistics/index.php https://www.calculator.net/mean-median-mode-range-calculator.html https://www.mathsisfun.com/data/standard-deviation-calculator.html https://www.statskingdom.com/standard-deviation-calculator.html	
Binomial tests	Chapter 5	https://stattrek.com/online-calculator/binomial.aspx http://statisticshelper.com/binomial-probability-calculator https://www.statisticshowto.com/calculators/binomial-distribution-calculator/	
One sample t-tests	Chapter 8	www.socscistatistics.com/tests/tsinglesample/default.aspx www.meta-calculator.com/t-test-calculator.php?panel-406-t-tests-input https://www.statskingdom.com/130MeanT1.html	Raw data only Raw data or Mean/SD/SE/N
Independent sample t-tests	Chapter 8	www.graphpad.com/quickcalcs/ttest1.cfm www.meta-calculator.com/t-test-calculator.php?panel-406-t-tests-input https://www.statskingdom.com/140MeanT2eq.html	Can use Mean/SD/SE/N or raw data
Paired sample t-tests	Chapter 8	www.graphpad.com/quickcalcs/ttest1.cfm www.meta-calculator.com/t-test-calculator.php?panel-406-t-tests-input https://www.statskingdom.com/160MeanT2pair.html	Can use Mean/SD/SE/N or raw data

One sample proportion tests	Chapter 8	https://epitools.ausvet.com.au/ztestone https://mathcracker.com/z-test-for-one-proportion https://www.infrlr.com/proportions/single-proportion-hypothesis-test-calculator https://www.statskingdom.com/111proportion_normal1.html	
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Two sample proportions tests	Chapter 8	https://www.socscistatistics.com/tests/ztest/default2.aspx https://epitools.ausvet.com.au/ztesttwo https://www.medcalc.org/calc/comparison_of_proportions.php https://mathcracker.com/z-test-for-two-proportions	Uses Chi-square test
Correlation	Chapter 9	https://ncalculators.com/statistics/correlation-coefficient-calculator.htm https://www.socscistatistics.com/tests/pearson/default2.aspx http://www.alcula.com/calculators/statistics/correlation-coefficient/ https://www.statskingdom.com/correlation-calculator.html	
Regression	Chapter 9	https://www.socscistatistics.com/tests/regression/default.aspx https://www.socscistatistics.com/tests/regression/default.aspx https://ncalculators.com/statistics/linear-regression-calculator.htm https://www.statskingdom.com/linear-regression-calculator.html	
Multiple Regression	Chapter 9	https://stats.blue/Stats_Suite/multiple_linear_regression_calculator.html https://www.socscistatistics.com/tests/multipleregression/default.aspx https://www.statskingdom.com/410multi_linear_regression.html	Two independent variables
Binary logistic regression	Odds Ratios, Chapter 4	https://www.statskingdom.com/420logistic_regression.html https://agrimetsoft.com/regressions/Logistic	Raw data only
Chi-square tests, one-sample	Chapter 10	http://vassarstats.net/csfit.html https://www.socscistatistics.com/tests/goodnessoffit/default2.aspx	

Chi-square tests, general	Chapter 10	https://www.medcalc.org/calc/comparison_of_proportions.php https://www.socscistatistics.com/tests/chisquare2/default2.aspx https://www.graphpad.com/quickcalcs/chisquared1/ http://vassarstats.net/csfit.html https://www.statskingdom.com/310GoodnessChi.html	<p>Up to 5 x 5</p> <p>Does goodness of fit and independence tests and McNemar test</p>
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Tests to compare variances	Chapter 10	https://www.statskingdom.com/210VarCHI1.html https://www.statskingdom.com/220VarF2.html https://www.statskingdom.com/230var_levenes.html	Chi-square F-test Levene test
Oneway ANOVA	Chapter 10	https://www.statskingdom.com/180Anova1way.html https://www.statskingdom.com/kruskal-wallis-calculator.html https://statpages.info/anova1sm.html https://www.danielsoper.com/statcalc/calculator.aspx?id=43 https://goodcalculators.com/one-way-anova-calculator/	Raw data only Kruskal-Wallis Test (non-parametric) Summary data, $k < 11$ groups
Two-way ANOVA	Chapter 10	https://www.statskingdom.com/two-way-anova-calculator.html	
Spearman Rank correlation	Chapter 11	https://www.socscistatistics.com/tests/spearman/default2.aspx https://atozmath.com/CONM/Ch3_RankCorr.aspx http://www.wessa.net/rwasp_spearman.wasp	
Two-sample Mann-Whitney U-test	Chapter 11	https://www.statskingdom.com/170median_mann_whitney.html https://www.socscistatistics.com/tests/mannwhitney/default2.aspx	
Sign Test for matched pairs	Chapter 11	https://www.socscistatistics.com/tests/signtest/default.aspx https://mathcracker.com/sign-test	

Rank-sum test	Chapter 11	https://www.statskingdom.com/175wilcoxon_signed_ranks.html https://www.socscistatistics.com/tests/signedranks/default2.aspx	Paired data
Test for normality	Chapter 6	https://www.statskingdom.com/130MeanT1.html	Shapiro-Wilks
Friedman test	N/A	Socscistatistics.com/tests/friedman/default.aspx Statology.org/friedman-test-calculator/ Astatsa.com/FriedmanTest/ Vassarstats.net/fried3.html	5 variables or fewer 3 variables only
Kolmogorov-Smirnov 2 sample test	N/A	Aatbio.com/tools/Kolmogorov-smirnov-k-s-test-calculator Scistatcalc.blogspot.com/2013/11/kilmogorov-smirnov-test-calculator.html Home.ubalt.edu/ntsbarsh/business-stat/otherapplets/ks.htm	
McNemar test	N/A	Graphpad.com/quickcalcs/McNemar.cfm www2.ccrb.cuhk.edu.hk/stat/confidence%20interval/McNemar%20test.htm	

		scistatcalc.blogspot.com/2013/11/mcnemars-test-calculator.html	
Kruskal-Wallis test	N/A	Socscistatistics.com/tests/Kruskal/default.aspx Mathcracker.com/Kruskal-wallis Statology.org/Kruskal-wallis-test-calculator/ Atozmath.com/conm/nonparatest.aspx?q=kw	Five or fewer groups
Effect sizes	N/A	https://www.socscistatistics.com/effectsize/default3.aspx https://www.campbellcollaboration.org/escalculator/html/EffectSizeCalculator-SMD-main.php https://www.psychometrica.de/effect_size.html https://www.ai-therapy.com/psychology-statistics/effect-size-calculator	Cohen's d Variety of measures
Testing legitimacy of data from summary statistics	N/A	See reference #15	Data reconstruction may be possible in some situations
Combining subgroup means/SDs into an overall mean/SD	N/A	https://www.statstodo.com/CombineMeansSDs_Pgm.php	Compare data from different journal articles

Others: <https://www.omnicalculator.com/statistics>

Figure A: Free websites for calculating various statistics used in basic statistics textbooks.

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Citation: Walter R Schumm, Merrick Dugan, William Nauman, Briana Sack, Julian Maldonado, Cayden Conyac and Clay Patterson. Using Free Websites to Perform Statistical Calculations in Basic Statistics Courses at High School or College Levels. SunKrist Social Res J. 2021; 2: 1009.

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