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Statistical Analysis
of Multiple-Choice Exams

Disraeli is often quoted as the source of a statement which appears to possess an inordinate attraction for many, regardless of its validity. He is reputed to have suggested the existence of three types of lies, in order of increasing severity, these are "lies, damned lies, and statistics."

The use of a multiple-choice format for hour exams at many institutions leads to a deluge of more or less significant statistical data which are unfortunately all too often either neglected or completely ignored. We will try to present an introduction of certain of the more common words or phrases which are encountered in the analysis of test results, so that these data may become more meaningful, and perhaps more useful as well. We feel obligated to note in passing that rare indeed is the academic discipline which cannot be accused of sharing Humpty Dumpty's claim that "a word means exactly what we choose it to mean, neither more nor less."

Analysis of the Mid-Point

We might best begin with a limited number of definitions of measures of the mid-point of a normal, Gaussian, or bell-shaped distribution of grades. The mode, or modal point, is the score or scores obtained by the largest number of students. The median is the score obtained by the middle student in the group, the score such that half of the students did better, and half did worse. The mean, $\bar{x}$, is the sum of the various test scores, x_i, divided by the number of students taking the exam, n.

$$\bar{x} = \frac{\sum (x_i)}{n}$$

(The mean is the quantity which was once called the average before the term average came to connote "normal," and therefore became a pejorative term.) The mean is simultaneously the most tedious of these quantities to calculate and the most representative measure of the mid-point of a test distribution.

Distribution of Scores

The simplest measure of the distribution of scores around the mean is the range of scores, or the difference between the highest and lowest scores, plus one. A better measure of the distribution of scores is the variance or standard deviation. The variance, σ^2, is the sum of the squares of the deviations of individual test scores (x_i) from the mean ($\bar{x}$), divided by the number of scores (n).

$$\sigma^2 = \frac{\sum (x_i - \bar{x})^2}{n}$$

The standard deviation, σ, is simply the square root of the variance. Although the number of students enrolled in introductory chemistry classes at some institutions often appears infinite, or at least transfinite, it is usually better to calculate the variance, σ^2, and standard deviation, σ, in terms of the number of degrees of freedom available in their determinations, $n - 1$.

$$\sigma^2 = \frac{\sum (x_i - \bar{x})^2}{(n - 1)}$$

Finally, the standard deviation, σ, can be determined more rapidly if the variance, σ^2, is calculated using either of the

following formulas:

$$\sigma^2 = \frac{\sum (x_i)^2 - \left[\sum x_i\right]^2 / n}{(n - 1)} = \frac{\sum (x_i)^2 - n\bar{x}^2}{(n - 1)}$$

Under idealized conditions, if the distribution of scores were truly Gaussian, 34.13% of the student's scores would fall between the mean and the mean plus one standard deviation, or between $\bar{x}$ and $\bar{x} - \sigma$. Therefore, 68.26% of the scores fall in the range of $\bar{x} \pm \sigma$. In this idealized distribution, 13.59% of the scores would fall between one and two standard deviations above the mean, or between one and two standard deviations below the mean. Only 2.14% of the scores would fall between two and three standard deviations above (or below) the mean, and a total of 99.72% of the scores would fall within a range of six standard deviations around the mean.

Calculation of Scaled Scores

Since the absolute or raw score on an exam does not indicate a student's performance relative to that student's peers, scaled scores are often calculated which unambiguously indicate the student's location within the distribution of scores. Two of the more popular scaled scores are the so-called z- and T-scores. The z-score is equal to the number of standard deviations that a student's raw score falls either above or below the mean. For example, if a student obtains a raw score of 15 on an exam with a mean of 45 and a standard deviation of 15, the raw score is exactly two standard deviations below the mean, and the z-score would be -2.00. A raw score of 90 on the same exam would correspond to a z-score of 3.00.

T-scores correspond to a scale on which the mean has been arbitrarily adjusted to 50, and where the standard deviation has been scaled to exactly 10 points. T-scores may be calculated from the raw score (x_i), the mean ($\bar{x}$), and the standard deviation (σ), using the following equation:

$$T = 10 \left[\frac{x_i - \bar{x}}{\sigma}\right] + 50$$

Our student who was two standard deviations below the mean would have a T-score of 30, whereas the student who was three standard deviations above the mean would have a T-score of 80.

Advantages of Scaled Scores

There are several advantages to z- or T-score data which make these scales attractive. First, and foremost, the students know where they stand in the course at all times. Students who are told their raw scores, the mean, and the range of scores, cannot always interpret these data correctly. Some are overly confident; others are unduly afraid of failure. Using scaled scores, the students know where they stand in comparisons with their peers. If the students are also informed of the typical distribution of grades, they can obtain an even better estimate of their standings in the course.

Scaled scores also allow the instructor to add any number of exam scores in the final analysis of grades without worrying about anomalous weighting of one or more of these exams. Regardless of the mean or standard deviation on a given exam, the z- or T-scores can be combined to produce a total which reflects the student's performance on each exam equally. If one wishes to drop the lowest exam score during the final analysis, it seems better to drop the lowest z- or T-score than

Statistical Analysis Of Multiple Choice Testing

Karl John Holzinger

Statistical Analysis Of Multiple Choice Testing:

   Statistical Analysis of Multiple Choice Testing ,2001 The multiple choice question exam is a very popular method of evaluation used by educators everywhere The Air Command and Staff College Distance Learning Department uses multiple choice exams for testing non residence students ACSC currently uses the Test Analysis and Development TAD software program s two quantitative measurements Ease Index and Differentiation Index to flag possible problem questions for qualitative review They also use student feedback to flag questions for review ACSC uses the Maxwell Academic Instructor School s Test Item Analysis Handout to examine qualitatively the flagged questions to determine which need revision The purpose of this paper is to determine if the ACSC Distance Learning Department is doing a good job at test evaluation and whether there are better ways to determine the quality effectiveness and fairness of multiple choice questions This paper compares the TAD program to the ITEMAN program for quantitative analysis For qualitative analysis prior studies and guidelines are compared to those used by AC SC This paper found that ACSC is doing a good job at test evaluation by using the best threshold values for the Ease Index and Differentiation Index to flag items This paper recommends that ACSC use the ITEMAN software program because of its ease speed and superior output This paper recommends that ACSC use the Biserial Correlation Coefficient as well to flag questions Lastly this paper recommends that ACSC use Hansen and Dexter s Item writing Guidelines for qualitative review of flagged questions   **Statistical Analysis of Multiple Choice Testing** Mark A Colbert,2025-05-22 The multiple choice question exam is a very popular method of evaluation used by educators everywhere The Air Command and Staff College Distance Learning Department uses multiple choice exams for testing non residence students ACSC currently uses the Test Analysis and Development TAD software program s two quantitative measurements Ease Index and Differentiation Index to flag possible problem questions for qualitative review They also use student feedback to flag questions for review ACSC uses the Maxwell Academic Instructor School s Test Item Analysis Handout to examine qualitatively the flagged questions to determine which need revision The purpose of this paper is to determine if the ACSC Distance Learning Department is doing a good job at test evaluation and whether there are better ways to determine the quality effectiveness and fairness of multiple choice questions This work has been selected by scholars as being culturally important and is part of the knowledge base of civilization as we know it This work was reproduced from the original artifact and remains as true to the original work as possible Therefore you will see the original copyright references library stamps as most of these works have been housed in our most important libraries around the world and other notations in the work This work is in the public domain in the United States of America and possibly other nations Within the United States you may freely copy and distribute this work as no entity individual or corporate has a copyright on the body of the work As a reproduction of a historical artifact this work may contain missing or blurred pages poor pictures errant marks etc Scholars believe and we concur that this work is important enough to be preserved reproduced and made

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Library Journal Melvil Dewey,Richard Rogers Bowker,L. Pylodet,Charles Ammi Cutter,Bertine Emma Weston,Karl Brown,Helen E. Wessells,1926 Includes beginning Sept 15 1954 and on the 15th of each month Sept May a special section School library journal ISSN 0000 0035 called Junior libraries 1954 May 1961 Also issued separately   New Public Personnel Studies ,1930   *Public Personnel Studies* ,1926   **Proceedings of the 1977 Computerized Adaptive Testing Conference Held at the University of Minnesota, July 19-22, 1977** David J. Weiss,1978   *Verbal Reports of Thinking as Data for Validating Multiple-choice Tests* Stephen Patrick Norris,1989   *Current Index to Statistics, Applications, Methods and Theory* ,1994 The Current Index to Statistics CIS is a bibliographic index of publications in statistics probability and related fields   **The ETS Test Collection Catalog** Educational Testing Service. Test Collection,1993 The major source of infornmation on the availability of standardized tests Wilson Library BulletinCovers commercially available standardized tests and hard to locate research instruments   **Visual Perception in Reading and Spelling** Sister Mary of the Visitation,1929

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