TRANSFORMED SCORES - STANDARD SCORES

OBJECTIVE:

To gain greater understanding of standard scores through first hand experience.

Like percentile ranks, standard and standardized scores have universal meaning. One of the most popular standardized scores is the IQ score. In this section, we focus on other ways to report test results by using standard and standardized scores.

GENERAL INFORMATION:

The term standard score, when used in the field of psychological testing, generally refers to a raw score that has been converted from one scale to another scale. The scale being converted to is typically a scale that is more widely used and easier to interpret. This second scale has a mean and standard deviation that have been arbitrarily set.

A *z* score, for example, is a raw score that has been transformed to a scale with a mean of 0 and a standard deviation of 1. To illustrate this point, consider Mary, a senior at Valdosta State University, who has earned a score of 80 on a test of Comparative Literature, a score of 72 on a test in Microbiology, and a score of 40 on a test in Art History. With this information, the raw scores alone, what can you say about Mary's performance on these tests or her standing in the classes? The answer is that you cannot say very much. Without knowing more information about where these raw scores place Mary's performance compared to the total distribution of raw scores for each of these tests or to some known distribution of scores, drawing any meaningful conclusions regarding her relative performance in each of these areas is impossible.

Suppose that the scores for all three of the tests were approximately normally distributed and that a) the distribution of the Comparative literature scores had a mean of 90 and a standard deviation of 10, b) the distribution of Microbiology test scores had a mean of 60 and a standard deviation of 12, and c) the distribution of the Art History scores had a mean of 40 and a standard deviation of 15. Now, what statements can be made regarding Mary's relative performance on each of these three tests?

Mary did best on the Microbiology test; her raw score of 72 falls at a point one standard deviation above the mean. Mary's next best score was on the Art History test; her raw score of 40 falls exactly at the mean of the distribution of scores. And finally there is Mary's performance on the Comparative Literature test; her raw score of 80 falls at a point one standard deviation below the mean. Converting Mary's raw scores to a scale that has a mean of 0 and a standard deviation of 1 - that is converting Mary's raw scores to *z* scores - we can say that Mary achieved a *z* score of +1 on the Microbiology test, a *z* score of 0 on the Art History test, and a *z* score of -1 on the Comparative Literature test.

The formula used to transform raw scores into *z* scores entails subtracting the mean from the raw score and dividing by the standard deviation.

$$z = \frac{X - M}{SD}$$

We'll use this formula to convert Joe's raw score of 89 on the Organic Chemistry test, the example used in Table 1, to a *z* score:

$$z = \frac{X - M}{SD} = \frac{89 - 74.24}{13.68} = 1.08$$

While *z* scores are relatively simple to use, they do have some computational disadvantages. Because a *z* score can be equal to 0 or can be negative, certain types of data manipulation become awkward. Also, many examinees are disturbed at hearing test scores reported as negative numbers. (How would you like to have -5 reported for your IQ?) For these reasons, as well as others, alternative standard score systems have been developed to linearly transform *z* scores (as well as raw scores) to a scale that does not contain negative numbers. Such systems are all "standardized" to the extent that both the mean and the standard deviation of the new scale have been arbitrarily set.

The general formula for linearly converting a *z* score to a standardized score (X') is expressed as follows:

$$X' = SD(z) + M$$

where: X' (called X prime) is the new standard score, and
M and SD are the values of the mean and standard deviation, respectively, of the new distribution.

To show how this works, let's convert a *z* score of 1 to a new score on a new scale. We'll use T-scores. T scores have a mean of 50 and a standard deviation of 10. Using the formula presented above, the new standardized score (X') or T score equivalent of a *z* score of 1, would be calculated as follows:

$$X' = (10)(1)+50 = 60$$

T scores were developed by W.A. McCall in the 1920's and are just one of many scales currently being used. T-scores are very popular in the field of clinical psychology and often used to report personality test results.

In the education field, a distribution with a mean of 500 and a standard deviation of 100 is very popular. (Remember the SATs? You'll see this standardized score distribution again if you are taking the GRE.) CEEB scores are also in this category.

Suppose we wanted to convert Marilyn's raw score of 57 in Organic Chemistry to a new score based on a distribution with a mean of 500 and standard deviation of 100. Using the formulas above (first *z* and then X'), the calculation of the new standardized score would proceed as follows:

$$z = \frac{X - M}{SD} = \frac{57 - 74.24}{13.68} = -1.26$$

$$X' = (100)\ (-1.26) + 500 = 374$$

When transforming scores, not dropping or misplacing negatives is very important. You can see in the above problem that if the negative had been forgotten, Marilyn's new score would have been 626 rather than 374 which would have placed her 1.26 standard deviations above the mean rather than 1.26 standard deviations below the mean.

NOTE: Terms used by clinicians, researchers, test manuals and book authors are not necessarily consistent when it comes to systems of standard scoring. For example, some test manuals and books reserve the term standard score for use with *z* scores; however, other transformed scores are also referred to as standardized scores.

YOUR HOMEWORK:

This assignment will give you practice in transforming scores. You may find the information on standard scores equivalents in your text useful.

NOTE: The mean and standard deviation are given in Exercise 1 and above on this page in the *z* score formula.

Name _____ Section _____ Date _____

TRANSFORMED SCORES - WORKSHEET

Convert the scores of Tim, Bob, and Wes to *z* scores, T-scores, IQ scores, and CEEB scores. Show all work neatly below; use back of this sheet if necessary. Round *z* scores to the hundredth place; round IQ, T, and CEEB to nearest whole number.

	z score	T-score	IQ score	CEEB score
Terri (74)	_____	_____	_____	_____
Bob (63)	_____	_____	_____	_____
Wes (88)	_____	_____	_____	_____

Standard Scores.

We'll begin with *z* scores. *z* scores are the same numbers as shown on the baseline of the curve without sigma. *z* scores can be computed by equating the mean of the raw score distribution to 0.00 and the standard deviation to 1.00. Remember, the relation between *z* scores and percentile equivalents as shown in the chart will be correct only when the data approximate a normal distribution.

T-scores are directly related to *z* scores. With T-scores, the mean of the raw score distribution is equated to 50, and the standard deviation is equated to 10. Therefore, a *z* score of +1.00 would be equal to a T-score of 60. In general *z* scores are expressed as decimals carried out to the hundredths place and T-scores are expressed as whole numbers. Thus, a *z* score of -3.00 is equal to a T-score of 20. The elimination of negative numbers encountered with the use of *z* scores is an advantage of using T-scores.

The College Entrance Examination Board has also created a system which has eliminated both negative numbers and decimals (CEEB scores). They have arbitrarily assigned a mean of 500 and the standard deviation at 100 points. Those familiar with the testing of the CEEB will recalled that an SAT-V score of 600 is a full standard deviation above the mean and has a percentile ranking of 84. A person with an SAT-V score of 600 indicates that they have scored in the top 16% on the CEEB basic norms for the verbal portion of the SAT.

Deviation IQs are another standard score system that is important to understand as a student of testing. Wechsler scales provide Verbal, Performance and Full Scale IQ scores based on standard scores with a mean of 100 and a standard deviation of 15. Thus, a person with an IQ of 100 is said to have an average IQ. For practical purposes, you can assume that roughly two-thirds of all persons will have IQs which fall between 85 and 115, that is, +/- 1σ from the mean.