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The Effective use of Standard Scores for Research in Educational Management

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Abstract: This study explained the use of standard scores otherwise known as z scores for research in educational management. Since a score is a unit distance between two limits, the individual given a score in percentage might have actually scored between the lower limit and the upper limit of that score. A score therefore represent the mid-point between the lower limit and the upper limit of the score. Therefore, standard score is a derived score that expresses how far a raw score is from some reference point such as the mean in terms of standard deviation units. It is useful in educational management as it gives an accurate definition of the score especially in data analysis. Although standard scores always assume a normal distribution, but if this assumption is not met, the scores cannot be interpreted as a standard proportion of the distribution from which they were calculated. However, standard or z scores can be used to compare raw scores that are taken from different tests especially when the data are at the interval level of measurement.

Key words: Educational, effective, management, research, scores, standard

INTRODUCTION

A score is a unit distance between two limits. We may illustrate this with a score of 60%. The individual given the score of 60% might have actually scored between 59.5 and 60.5%. This score of 60% represents the mid-point between 59.5 and 60.5% (Alonge, 1998).

A score is a number in a continuous series. Variables and attributes that are capable of any extent of subdivision e.g. all physical measures such as height from 1ft, 2ft, 3ft, 4ft, 5ft and above are said to be in continuous series. Educational variables are usually in continuous series. In analyzing such data, the student t-test statistic can be used (Moore, 1994; Baddie and Fred, 1995; Onipede, 2003).

Discrete series exhibit wide gaps or variations such as a salary scale ranging from $97 to $120 per week or from $94 to $455 per mouth. The relationship between these figures can be known through the use of chi-square statistic.

STANDARD SCORES

A standard score is a derived score that expresses how far a raw score is from some reference point such as the mean in terms of standard deviation units (Yin, 1994; Omonijo, 2001). It is a measure of relative position that is appropriate when the data for the test are in the interval or ratio scale of measurement. The most commonly used standard scores are Z scores, T scores and stanines (Norusis, 1993; Gay, 1996; Bandele, 1999). Standard scores enable scores from different tests to be compared on a common scale. Unlike percentiles, the researcher can validly average the test scores and covert them to standard scores. He can also average them and derive a valid final index of average performance. Standard scores are scores that enable us to identify the relative position of a score in a distribution. We can use standard scores to compare two or more distributions. They also help to compare the level of performance of an individual at different times. Thus, when raw serves are converted to a common standard, they are referred to as standard scores and they are expressed by standard deviation units (Oluwatayo, 2003). As such, each raw score may be given an equivalent z score.

Z scores: A z score is the most basic standard score. It expresses how far a score is from the mean in terms of standard deviation units. A score that is exactly on the mean corresponds to a z of 0. Thus, if the mean of a group of scores is 100 and the standard deviation is 15, therefore a score that is exactly 1 standard deviation above the mean such as an IQ of 115 corresponds to a z of +1.00. A score that is exactly 2 standard deviation above the mean such as an IQ of 130 corresponds to a z of + 2.00. A score that is exactly 1 standard deviation below the mean such as an IQ of 85 corresponds to a z of -1.00. A score that is exactly 2 standard deviation below the mean such as an IQ of 70 corresponds to a z of -2.00. If therefore, a set of scores is transformed into a set of z scores, the new distribution would have a mean of 0 and a standard deviation of 1 (Gay, 1996; Owoyemi, 2000; Bello, 2000).

Example 1: Assuming that Mr. Charles asks a schoolteacher of his son ‘how has Mike performed in the English Language and Mathematics tests?’ If the teacher tells him that Mike’s English Language score was 50

while his Mathematics score was 40, the parent might not yet know how well Mike has performed in the two tests. He might even had the wrong impression that Mike is better in English Language than in Mathematics whereas in actual fact 50 might be a low score on the English Language test while 40 might be a high score in the Mathematics test.

Suppose the teacher told the parent that the average score in English Language was 60 while the average score in Mathematics was 30, the parent would then be convinced that Mike performed better in Mathematics than in English Language. If the standard deviation on each of the two tests was 10, then, the true picture of Mike's performance level would be shown. Since his score in English Language is exactly 1 standard deviation below the mean (60-10 = 50), his z score would be –1.00. Secondly, since his score in Mathematics is 1 SD above the mean (30+10= 40), therefore, his z score would be +1.00 (Table 1).

It should, however, be noted that scores might not be exactly 1 standard deviation or 2 standard deviation or 3 standard deviation above or below the mean all the terms. There is always a formula that is used to convert a raw score into a z score. The formula is indicated as follows:

$$Z = (X - \bar{x}) / SD$$

where,

X = Raw score
$\bar{x}$ = Mean
SD = Standard Deviation

The only problem with z scores is that they involve negative numbers and decimals. Hence, it is difficult to explain to Mr. Charles that his son Mike was -1.00 in the test on English Language and +1.00 in the test in Mathematics. In order to solve this problem, it is necessary to transform z scores into T scores thereby eliminating the negative signs and decimals.

T scores: A T score is a z score expressed in a different form. In order to transform a z score to a T score, we have to simply multiply the z score by 10 and add 50 (Moore, 1994; Bandele, 1999). The T score is also referred to as a capital Z score. The formula for the T score is as follows:

T Score = 10z + 50 (Kolawole, 2001)

Example 2:What is the T score for a z score of 0?

Solution: A score of 0 (that is, the mean score) becomes a T score of 50.

T = 10z + 50, that is, T = 10 (0) + 50

Table 1: z-scores

Subjects	Scores	$\bar{x}$	SD	Z
English Language	50	60	10	-1.00
Mathematics	40	30	10	+1.00

T = 0 + 50
T = 50

Example 3: A z score of -1.00 becomes a T score of 40; that is:

T = 10 (-1.00) + 50
T = - 10.0 + 50
T = -10 + 50
T = 50 –10
T = 40

Example 4:A z score of +1.00 becomes a T score of 60; that is:

T = 10 (+1.00) + 50
T = 10.0 + 50
T = 60

In summary, when scores are transformed into T or Z scores, the new distribution would have a mean of 50 and a standard deviation of 10. It would therefore, be easy for the teacher to tell Mr. Charles that Mike was a 40 in English Language and a 60 in Mathematics, while the average score was 50, than to tell him that Mike was a -1.00 in English Language and a +1.00 in Mathematics. Thus, if the raw score distribution is normal, the z score would also be normal and the transformation 10z + 50 would produce a T distribution.

Example 5: Suppose that the raw scores of five students in a Mathematics test are as follows:

A	10
B	20
C	30
D	40
E	50

Convert the scores into z and T scores (Table 2).

$\bar{x} = Sx/N$
$\bar{x} = 150/5$
$\bar{x} = 30$

Varince (σ^2)

$\sigma^2 = (x-\bar{x})^2 / N$
$\sigma^2 = [1000] / 5$
$\sigma^2 = 250$

Table 2: Scores of students in a mathematics test

X	x- ȳ	$(x-ȳ)^2$
10	10-30 = -20	400
20	20-30 = -10	100
30	30-30 = 0	0
40	40-30 = +10	100
50	50-30 = +20	400
∑x =150		$\sum(x-ȳ)^2$ = 1000

SD or σ = $\sqrt{[(x-ȳ)^2/ N]}$
SD or σ = $\sqrt{[1000/ 5]}$
SD or σ = $\sqrt{250}$
SD or σ =15.8

In order to convert raw scores of the students to z scores, we have to apply the following formula to each score.

z = X -ȳ/ SD

For Student A:
z = X -ȳ/SD
z = 10 -30/15.8
z = -20/15.8
z = -1.27

Interpretation: The z score of -1.27 indicates that Students A's score was 1.27 standard deviation below the average.

For student B:
z = X -ȳ/SD
z = 20-30/15.8
z = -10/15.8
z = -0.63

Interpretation: The z score of -0.63 indicates that Students B's score was 0.63 standard deviation below the average.

For student C:
z =X -ȳ/SD
z = 30-30/15.8
z = 0/15.8
z = 0.00

Interpretation: The z score of 0 indicates that Students C's score was at the average.

For student D:
z = X - ȳ/ SD
z = 40-30/15.8
z = 10/15.8
z = 0.63

Interpretation: The z score of 0.63 indicates that Students D's score was 0.63 standard deviation above the average.

For student E:
z = X -SD
z =50-30/15.8
z =20/15.8
z =1.27

Interpretation: The z score of 1.27 indicates that Students E's score was 1.27 standard deviation above the average. It should be noticed from the calculations that the z score for student C is 0.00.

This is because the raw score is the same as the mean score. Hence, his score has no distance from the mean. On the other hand, the scores of students' A and B were below the mean as their scores were negative while the scores of students' D and E were above the mean and the z scores were positive.

However, if we wish to eliminate the negative signs, we have to convert the z scores to T or Z scores. In doing this, we have to multiply each z score by 10 and add 50. Thus, the formula for the T or Z score is:

T = 10z + 50 or Z = 10z + 50

In applying this formula to the z scores of students A, B, C, D and E, the following process should be taken:

For student A:
T = 10z + 50
where,
z =-1.27
T = 10 (-1.27) + 50
T = -12.7 +50
T = 50-1.27
T or Z = 48.73

For student B:
T = 10z + 50
where,
z = -0.63
T = 10 (-0.63) + 50
T = -6.3 +50
T = 50-6.3
T or Z = 43.70

For student C:
T = 10z + 50
where,
z = 0.00
T = 10 (0.00) + 50
T = 0.00 +50

T = 50 - 0.00
T or Z = 50

For student D:
Z = 10z + 50
where,
z = 0.63
T = 10 (0.63) + 50
T = 6.3 +50
T or Z = 56.30

For student E:
Z = 10z + 50
where,
z = 1.27
T = 10(1.27) + 50
T = 12.7 +50
T or Z = 62.70

Example 6: If there are two examinations, one in Social Statistics and the other in Educational Statistics, and a certain student scored 51 in both. Suppose in examination A, the mean score in that class was 45. So, the student scored above the mean. Suppose in examination B, the mean score in that class was 45 and he scored above the mean. Assuming, the standard deviation for examination A is 2 while the standard deviation for examination B is 5, compare the scores of the student in both examinations so as to identify what percentage of the class that scored higher than him or what percentage of the class that scored lower than him.

In examination A:
z = xi –ȳ/ SD
z = 1 – 45 = +6 /22
z = 3

This indicates that the deviation is 3 times higher than the mean. If he had scored 39, that would have given a negative z-score, and when the z is negative, it shows the score is below the mean.

Ie Z = 39 – 45 = -6 = -3/22
z = -3

Thus, the deviation is –3 times below the mean or away from the mean.

In examination B:
z = xi -ȳ/SD
z = (51 - 45)/5 = +6/5
z = 1.2

Table 3: Standard scores of students

	A Class	B Class
Raw scores	82	90
Class mean	71	86
SD	6.3	4.0

This shows that the deviation is only 1.2 times higher than the mean or away from the mean. If he had scored 39, that would have given a negative z-score and when the z is negative, it indicates that the score is below the mean. i.e.,

z = (39-45)/5 = -6 /5
z = -1.2

This indicates that the deviation is -1.2 times below the mean or away from the mean.

Example 7: Examine the standard scores of two students A and B in a Mathematics examination as indicated in Table 3 and transform the scores into z-scores. Using the z score formula, each student's raw score could be transformed into z score as follows:

Student A:
z = x -ȳ/SD
z = (82 - 71)/6.3 = 11/6.3 = 1.7
z = 1.7

Student B:
z = x –ȳ/SD
z = (90 - 86)/4.0 = 4 /4.0 = 1.0
z = 1.0

In comparing the two scores, it is difficult to say categorically that student A did better than student B in real terms since the Mathematics test might be different in the degree of difficulty while the two classes might differ in the level of ability. Other variables might also have affected the performance level of each student therefore making if difficult to determine which student actually performed better than the other. Notwithstanding, it appears that student A performed relatively better than student B in the Mathematics examination.

Stanines: Stanines are standard scores that divide a distribution into nine parts. Stanine scores can be described as a nine-point scoring system in which the scores range from 1 to 9. Stanine scores have a mean of 5 and a standard deviation of 2 (Nachmais, 1992; Kinnear and Gray, 1994; Awosami *et al*., 1999; Adeyemi, 2003). Otherwise known as 'standard nine,' stanines are derived by using the formula:

Stanines = 2z + 5

Stanines therefore, divide a population into nine groups and place the individual into any of the nine categories according to his or her raw scores. In computing stanines, the resulting values should be rounded up to the nearest whole number. Thus, the stanines 2 to 8 represent ½ SD of the distribution while stanines 1 and 9 include the remaining SD. Stanine 5 includes $^{1}/2$SD around the mean. It equals mean ($\bar{x}$) $\pm^{1}/4$ SD. Stanine 6 is from $+^{1}/4$SD to $+^{3}/4$SD that is, $^{1}/4$ SD + 1/2SD and so on. Stanine 1 includes any score less than $-1^{3}/4$ SD below the mean while Stanine 9 includes any score greater than $+1^{3}/4$ above the mean. Stanines are commonly used in the school system. They are usually shown in norms table for standardized tests. Although they are not as exact as other standard scores, they are useful as a basis for grouping and for selecting students for special programmes (Adeyemi, 1998; Aghenta, 2000; Kolawole, 2001; Asaolu, 2003). An example is the selection of students who scored in the first, second and third stanines on a standardized Mathematics test.

Advantage of using standard or z scores: One major advantage of standard or z scores is that they can be used to compare raw scores that are taken from different tests especially when the data are at the interval level of measurement.

Disadvantage: The main disadvantage of standard scores is that they always assume a normal distribution. But if this assumption is not met, the scores cannot be interpreted as a standard proportion of the distribution from which they were calculated. For example, if the distribution is skewed, the area with the standard deviation of 1 to the left of the mean is not equal to the area within the same distance to the right of the mean.

CONCLUSION

Considering the foregoing, it was concluded that Standard Scores are critical requirement for research into problems dealing with data analysis in educational management. This is evident in the fact that standard or z scores can be used to compare raw scores that are taken from different tests especially when the data are at the interval level of measurement.

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