WEB PAGE FOR CHAPTER 8

MULTIPLE CHOICE QUESTIONS – SET A

1 If the scores are clustered to the low end of the frequency distribution the distribution is:
- (a) unimodal
- (b) multi-modal
- (c) negatively skewed
- (d) positively skewed

2 If a distribution is unimodal and symmetrical then:
- (a) the mean is greater than the mode and the mode is greater than the median
- (b) the mode and median are equal but both less than the mean
- (c) the mean is less than the mode and the mode is less than the median
- (d) the mean, mode and median are equal

3 Skewness in a distribution can be determined by comparing:
- (a) the mode and the median
- (b) the median and the mean
- (c) the mean and the mode
- (d) any two measures of central tendency

4 For any distribution of raw scores the mean and standard deviation of Z scores are:
- (a) 1.0
- (b) 0.1
- (c) 0.0
- (d) 1.1

5 A normal distribution always has:
- (a) a mean of 100 and an SD of 15
- (b) a mean of 50 and an SD of 10
- (c) a mean of 0 and an SD of 1
- (d) a mean of 1 and an SD of 0

6 A probability of .05 means:
- (a) the event lies within the middle 95% of the distribution
- (b) the event lies outside the middle 95% of the distribution
- (c) the event will occur 50% of the time
- (d) the event will occur once every five times

7 The frequency distribution of a normally distributed set of values can be completely described by:
- (a) the mean and median
- (b) mean and SD
- (c) median and variance
- (d) median and SD

8 To calculate a Z score we need to know:
- (a) the mean and standard deviation
- (b) the raw score and the mean
- (c) the raw score and the standard deviation
- (d) the raw score, the mean and the standard deviation

9 A Z score of + 1.0 implies a value better than what percentage of the values?
(a) 50%
(b) 68%
(c) 75%
(d) 84%

10 The area under the normal curve is considered to be equal to:
(a) 1.0
(b) 10
(c) 100
(d) varies depending on the size of sample

11 If a group of subjects have a mean score of 20 and a standard deviation of 4 on a test, approximately 95% of the scores lie between:
(a) 16 and 28
(b) 18 and 22
(c) 16 and 24
(d) 12 and 28

12 In a normal distribution, what proportion of scores fall within the interval between the mean and one standard deviation above the mean?
(a) 25% approx
(b) 34% approx
(c) 64% approx
(d) 84% approx

13 A set of values has M = 75 and SD = 25. What is the Z score for a raw score of 100?
(a) +1.0
(b) +2.0
(c) +3.0
(d) –1.0

14 In a normal distribution the area to the left of Z = 0 contains what percentage of the distribution?
(a) 0
(b) 25%
(c) 50%
(d) 100%

15 What does $p<0.05$ mean?
(a) the probability of a chance occurrence of more than 1 in 20
(b) the probability of a chance occurrence of less than 1 in 20
(c) the probability of a chance occurrence of less than 5 in 20
(d) the probability of a chance occurrence of less than 1 in 100

16 Can outcomes be significant at the 1% level but not at the 5% level?
(a) false
(b) true
(c) sometimes
(d) depends on N

SPSS ACTIVITY

Access SPSS Chapter 8 Data File. Assess scale variable '*age*' for normality and transform using an appropriate technique.

MULTIPLE CHOICE QUESTIONS – SET B

1 If a distribution has scores clustered more at one end than at the other then the distribution is said to be:
   (a) unimodal
   (b) assymmetrical
   (c) bimodal
   (d) skewed

2 If a distribution is symmetrical –
   (a) the mean, median and mode coincide
   (b) the mean is greater than the median
   (c) the mode is greater than the mean
   (d) the mean equals the median but the mode has a different value

3 A positively skewed distribution is most likely to have:
   (a) a mean greater than the median
   (b) a mean smaller than the median
   (c) a mean equal to the median
   (d) negative outliers
   (e) mean=median=mode

4 A negatively skewed distribution is:
   (a) skewed to the right
   (b) skewed to the left
   (c) represented by a mean greater than the median
   (d) represented by a mode smaller than the mean
   (e) none of the above

5 An examination which very clearly distinguished between those students who knew the material and those who did not would most likely yield:
   (a) a symmetrical distribution
   (b) a unimodal distribution
   (c) a bimodal distribution
   (d) an assymetrical distrbution

6 Skewness in a distribution affects:
   (a) the mean the most
   (b) the median the most
   (c) the mode the most
   (d) the mean, median and mode equally

7 If a value was $Z = 0$, is this value in its original terms?
   (a) below the mean
   (b) above the mean
   (c) equal to the mean
   (d) equal to zero?

8 An individual obtains a Z value of +2 on a test. It can be concluded that:
   (a) the grade is twice as far from the mean as other grades
   (b) the person did well on the test
   (c) no interpretation is possible
   (d) the distribution was skewed

9 A probability of 0 means that:
(e) probability cannot be calculated
(f) the event is impossible
(g) the event is improbable
(h) the event occurs so rarely there is no means of knowing what its probability is

10 If an event lies at a significance level of $p<.01$ then:
(a) it is unlikely to occur
(b) it cannot be significant at the .05 level
(c) if 1,000 cases were plotted only 10 would reach this level or beyond
(d) it is not a chance event

11 In a normal distribution:
(a) all scores lie between $\pm 3Z$
(b) 68.26% of scores lie between $+1/-1Z$
(c) 68.26% of values are incorrect
(d) 68.26% of values lie between $\pm 2Z$

12 Post office workers earn a mean weekly income of \$750 with an SD of \$150. Income distribution is normal. Approximately 68% of workers earn between:
(a) \$400 and \$900
(b) \$700 and \$750
(c) \$600 and \$900
(d) \$500 and \$900

13 In the question above, the percentage of workers earning between \$450 and \$1,050 is approximately:
(a) 68%
(b) 50%
(c) 99%
(d) 95%

14 Using the data in question 12 above, what percentage would earn less than \$600?
(a) 50%
(b) 16%
(c) 84%
(d) 34%

15 The 95% confidence interval for a set of data with M= 20 and SD = 2 is:
(a) 20 plus or minus 2
(b) 20 plus or minus 1.96
(c) 20 plus or minus 1.96×2
(d) $2 + 1.96 \times 20$

ADDITIONAL QUESTIONS

1 A distribution has a mean = 60 and SD = 12.
(a) What raw score has $Z = +.25$?
(b) What value corresponds to $Z = -1.33$?

2 A population of values has M = 45 and SD = 5. Find Z scores for the following values:
50; 40; 35; 45

3 For the same population, which raw scores correspond to the following Z scores?
+1.5; –3.0; –1.5; +2.0

4 Why is it possible to compare scores from different distributions after converting each distribution into Z scores?

5 For distribution A, M = 20 and SD = 7. For distribution B, the M = 23 and SD = 2. In which distribution will a raw score of 27 have a higher standing?

6 A population has M = 37 and SD =10. If this distribution is transformed into a new distribution with M + 100 and SD = 20, what new values will be obtained for each of the following scores?
47; 52; 57

7 For a distribution of raw scores the mean = 45 and the Z score for 55 is calculated by a student as –2.0. Regardless of the value of the SD, why must this Z score be incorrect?

8 In a particular exam a raw score of 65 corresponds to a Z score of +2.00 and a raw score of 50 to a Z score of –1.00. What is the mean and standard deviation?

9 On a statistics test you obtain a score of 7. Would you rather be in the morning group where the SD = 2 or the afternoon group where the SD = 1. The mean is 6 for both.

10 What proportion of values falls between Z = –1.0 and Z = +2.0?

11 For normal distribution with M = 80 and SD = 10, find the probability value of obtaining a value:
(a) greater than 90
(b) less than 100
(c) between 60 and 100

12 A population has M = 200 and SD = 50, what scores approximately delineate the 95% confidence intervals and the 68% confidence intervals?

13 In a normal distribution, with M = 100 and SD = 15 what percentage of cases will fall between 85 and 100?

14 For a normal distribution with M = 80 and SD = 12:
(a) what is the probability of randomly selecting a score greater than 92?
(b) what is the probability of randomly selecting a score less than 68?

15 The scores on the statistics test you have just taken were normally distributed and the mean was 70. Would you hope for a small or large standard deviation on the test if you had done very well on it.

16 In a set of exams a business student obtained the following:

Applied research	70 marks	–.9Z
Marketing	58 marks	–.8Z
Management	67 marks	.3Z
Accountancy	67 marks	.35Z

In which subjects did they do best and worst.

ADDITIONAL MATERIAL

The Z Score Table. What is it and how can it be used?

The Z table below enables us to calculate areas between any Z scores under the normal curve. In the main text we have limited these areas to whole number Z scores like ±1 and ±2 in our explanations so you gained a grasp of the basic principles. The areas and figures we gave you, as you gather from the slight changes we made near the end of the chapter, were very close approximations. But using this table we can:

- provide the probability of any particular value if we know its Z score;
- provide the probability of obtaining a value between specific Z scores or within particular areas under the curve; and
- translate from area into the exact numbers of cases plotted within the segment.

We will show you how to use this table to obtain accurate figures.

Look at the table below. Z scores are listed down the left hand side column with each tenth of a Z score in columns listed across the top. The four-figure numbers located in the body of the table are in fact the probabilities of finding an observation at that Z score point. They can be turned into percentages by moving the decimal point two places back. For example, a tabled figure of .3413 found opposite Z = 1.0 indicates that 34.13% of values or area lie between Z = 0 and Z = 1. As another example, 1.55Z = .4394 or 43.94% of values or area under the curve lies between Z = 0 and Z = 1.55. These two examples also indicate that 34.13% and 43.94% of cases plotted in the graph can be found within those areas respectively.

The table covers only one half of the curve, from 0 (the mean) to the positive end. Since the normal distribution is symmetrical, the proportions for the other half of the curve, i.e. for –Z are exactly the same as +Z. Therefore the table is also valid for the area 0 to the negative end of the curve. If the area you are interested in extends on both sides of M (or 0) then it is necessary to add the two relevant areas together. Here are some examples for you to follow:

Z Score Table

Fractional parts of the total area (taken as 10,000) under the Normal Probability Curve, corresponding to distances on the baseline between the mean and successive points laid off the mean in units of Standard Deviation. Example: Between the mean, and a point 1.3, is found 40.32% of the entire area under the curve, or there is a probability .4032 of a value occurring between 0 and 1.3Z.

Z	.00	.01	. 02	.03	.04	.05	.06	.07	.08	.09
0.0	0000	0040	0080	0120	0160	0199	0239	0279	0319	0359
0.1	0398	0438	0478	0517	0557	0596	0636	0675	0714	0753
0.2	0793	0832	0871	0910	0948	0987	1026	1064	1103	1141
0.3	1179	1217	1255	1293	1331	1368	1406	1443	1480	1517
0.4	1554	1591	1628	1664	1700	1736	1772	1808	1844	1879
0.5	1915	1950	1985	2019	2054	2088	2123	2157	2190	2224
0.6	2257	2291	2324	2357	2389	2422	2454	2486	2517	2549
0.7	2580	2611	2642	2673	2704	2734	2764	2794	2823	2852
0.8	2881	2910	2939	2967	2995	3023	3051	3078	3106	3133
0.9	3159	3186	3212	3238	3264	3290	3315	3340	3365	3389
1.0	3413	3438	3461	3485	3508	3531	3554	3577	3599	3621
1.1	3643	3665	3686	3708	3729	3749	3770	3790	3810	3830
1.2	3849	3869	3888	3907	3925	3944	3962	3980	3997	4015
1.3	4032	4049	4066	4082	4099	4115	4131	4147	4162	4177
1.4	4192	4207	4222	4236	4251	4265	4279	4292	4306	4319
1.5	4332	4345	4357	4370	4383	4394	4406	4418	4429	4441
1.6	4452	4463	4474	4484	4495	4505	4515	4525	4535	4545
1.7	4554	4564	4573	4582	4591	4599	4608	4616	4625	4633
1.8	4641	4649	4656	4664	4671	4678	4686	4693	4699	4706

1.9	4713	4719	4726	4732	4738	4744	4750	4756	4761	4767
2.0	4772	4780	4783	4788	4793	4798	4803	4808	4812	4817
2.1	4821	4826	4830	4834	4838	4842	4846	4850	4855	4857
2.2	4861	4864	4868	4871	4875	4878	4881	4884	4887	4890
2.3	4893	4896	4898	4901	4904	4906	4909	4911	4913	4916
2.4	4918	4920	4922	4925	4927	4929	4931	4932	4934	4936
2.5	4938	4940	4941	4943	4945	4946	4948	4949	4951	4952
2.6	4953	4955	4956	4957	4959	4960	4961	4962	4963	4964
2.7	4965	4966	4967	4968	4969	4970	4971	4972	4973	4974
2.8	4974	4975	4976	4977	4977	4978	4979	4979	4980	4981
2.9	4981	4982	4982	4983	4984	4985	4985	4986	4986	
3.0	4986.5		4987.4		4988.2		4988.9		4989.7	
3.1	4990.3		4991.0		4991.6		4992.1		4992.6	
3.2	4993.129									
3.3	4995.166									
3.4	4996.631									
3.5	4997.674									
3.6	4998.409									
3.7	4998.922									
3.8	4999.277									
3.9	4999.519									
4.0	4999.683									
4.5	4999.966									
5.0	4999.997133									

Example 1

What proportion of the total area lies *between* 0 and 1.5Z?

To find the answer look up 1.5 in the Z column. Then look across to the next column. The answer is 43.32% (since the figures are given as proportions of 1).

Example 2

What proportion of the total area lies *beyond* -2-30Z?

Look up -2.3Z (forget the negative sign). It is 48.93%. But remember we want the area beyond, therefore the answer is 1.07%, i.e. 50-00%–48-93%. Remember the area of the distribution covered by the table is 50% whether the negative half or the positive half.

Example 3

If one of the Z scores is positive but the other is negative, we find the proportion of the curve between them by adding values.

What proportion of the curve lies between Z of –1.6 and Z of .5?

In the table we find the proportion between Z = –1.6 and the mean is .4452, and from the mean to Z = +.5 is .1915. Therefore, the proportion between Z = –1.6 and Z = +.5 is .4452 + .1915, or .6367. Thus 63.67% of the cases in a normal distribution will fall between +.5Z and –1.6Z.

Example 4

When we want the proportion of the normal curve falling between two Z scores with the same sign, we subtract the area for the smaller Z score from the area for the larger Z score. For example, let us find the proportion of cases between a Z of –.68 and a Z of –.98 in a normal distribution.

We can ignore the negative sign. The table indicates that the area between the mean (Z = 0) and a Z of .98 is .3365, while the area between the mean and a Z of .68. is .2517. Thus, the area between Z = .68 and Z = .98 is found by subtracting the area for the smaller Z score from the area for the larger Z score; in this case, .3365 – .2517 = .0848. We would expect 8.48% of the cases in a normal distribution to fall between these Z score points.

When you are working these sort of problems it is useful to draw a rough sketch of the normal distribution and mark the required Z scores on it and shade in the area you are looking for. This helps to visualize what you are trying to determine. Remember too that you cannot go directly from a raw score to the normal distribution table. You must always go by way of Z scores.

Most standardized published job selection tests of intelligence, aptitude, and attitude are standardized to give a mean of 100 and a standard deviation of 15, i.e. a person who scores an IQ of 130 is two standard deviations above the mean, and referring to the table, we note that this score is bettered by only approximately 2.5% of the population.

The examples above showed how to calculate the percentage of area plotted under various parts of the curve. We can go even further, for if we know the total number of scores in the distribution, we can calculate the number that fall between various segments of the curve, for these are simply proportions of area turned into percentages of the total number of scores.

Example 5

If we possess 10,000 normally distributed scores from the public servants of a major country on a test that measures anxiety level, how many scores lie between +1 Z and –1 Z? Draw a sketch to help you.

Entering the table, we read that 3413 or 34.13% of the area is located between M and +1. The same percentage obviously exists between M and –1. This implies that 68.26% of the area is involved and therefore 68.26% of the scores. Since there are 10,000 scores plotted, we must have 6826 scores in the region between –1Z and +1Z

Example 6

Using the same 10,000 anxiety scores, we want to provide special counselling for those whose scores lie in the top 10% to lower their anxiety level which is believed to be impeding their performance in their jobs. We need to know what the cut-off score is so we can select our 10%. Let us assume the mean is 60 and the standard deviation 10.

Turning to the table, we are looking for the Z score that relates to 4,000 or 40%. Remember that the table covers only half the curve. The Z score is 1.28. Since the SD = 10, a Z of 1.28 is equal to approximately 13 points on the base line so we must add a score of 13 to the mean to locate the cut-off point. The cut-off point is 73. This example shows that if we also know the M and the SD we can allocate actual scores instead of Z score positions to demarcate areas.

Example 7

The salaries of 1,000 employees are normally distributed with a mean of \$70,000 and a standard deviation of \$8,000. In order to calculate the number of employees whose salaries lie between \$60,000 and \$90,000 the corresponding values of Z need to be found.

For the \$60,000 level salary $Z = \dfrac{60{,}000 - 70{,}000}{8{,}000} = -1.25$

For the \$90,000 level salary $Z = \dfrac{90{,}000 - 70{,}000}{8{,}000} = +2.5$

From the table the area under the curve between 0 and Z = –1.25 is 0.3944, while the area between 0 and +2.5 is .4938. This sums to a total of .8882 or 88.82% of the area under the curve. Since there are 1,000 employees, the number of employees in the salary range is 888.

Example 8

Given a normal distribution of 1,000 scores with M = 80 and SD = 12, what two scores delimit the area containing the middle 50% of the scores? Draw a sketch to give yourself a visual impression of what you are seeking.

The middle 50% must be equally divided 25% on each side of the mean. Turning to the table, we locate 2500 and read off the Z score. This is Z =.675 approx. Since the SD is 12 this Z score translates into an amount of 8 points approximately (i.e. two-thirds of an SD). Therefore the middle 50% is contained by Z scores of + .675 Z to –.675 Z or in score terms 80 ±8. Thus the scores are 88 and 72 approximately.

Example 9

Telecom wants to find out the probability for any phone message lasting between 150 and 180 seconds given that the mean length of call is 150 secs with a SD of 15 secs in order to determine whether more lines are needed. The time of 180 secs is 2 SD above the mean and the table reveals that there is an area of .4772 under the curve between the mean and +2Z. Telecom comes to three conclusions with this information.

- There is a 47.72% chance that any single telephone call will last between 150 and 180 seconds.
- 47.72% of all phone calls last between 150 and 180 seconds.
- The probability that a call will last more than 180 seconds is 2.28%.

Example 10

You may remember it was a failed O ring that caused the US space shuttle disaster. O rings seal connections to prevent fuel leaks. One type must be 5 cm in diameter to fit correctly. It can vary only by 0.25 cm without causing a leak. The manufacturers claim that their ring averages 5 cm with an SD of .17 cm. Determine the proportion of rings that will fit correctly.

Since there is a tolerance around the mean of .25 cm the range of acceptable ring size is 5cm ±.25 cm or 4.75 cm – 5.25 cm. The Z limits for these points are calculated as follows:

$$Z = \frac{4.75 - 5.0}{.17} \quad \text{and} \quad \frac{5.25 - 5.0}{.17} = -1.47 \ \text{ and } \ +1.47$$

The table shows that the area between Z = 0 and Z = 1.47 = .4292. This must be doubled to cover both sides of the distribution producing a proportion of .8584. Thus the proportion of correctly fitting rings is 85.84%

Calculating an X value from a known probability

Sometimes we have to determine what value of X will yield a desired probability. The government is preparing the nation's annual Budget and national elections are not far off. Looking for programmes that might secure their return to office, the government has given you as a public servant the task to identify the nation's poorest 10% in terms of annual family income in order to provide them with a one-off family supplement bonus of a fixed amount. Assume we know the mean population annual income and the SD, $30,000 and $5,000 respectively. We need to look in the table to find what the Z score is for the point where we have the split into the lowest 10% and the rest of the population. Since the table covers only 50%, we must take 10% away from 50% to give us 40%. Remember the table measures from the mean outwards; we need to know where the critical point of the 40%/10% cut-off: 40% is written in the table as .4000. The closest we can get is .3997 which locates it at 1.28Z. We now need to compute the income equivalent to Z = – 1.28.

$$1.28 = \frac{X - 30{,}000}{5{,}000} \quad X = \$23{,}600$$

Thus anyone with a family income of $23,600 or less will receive this proposed family supplement. Since we know the size of the population we can also make a fairly tight estimate of how many fall into the defined category and inform the Finance Department of the approximate cost of the one-off payment.

We hope you can see how useful the combination of normal distribution, and Z scores are in calculating important facts on which decisions have to be made.

ANSWERS TO MULTIPLE CHOICE QUESTIONS – SET A

1 (d), 2 (d), 3 (c), 4 (b), 5 (c), 6 (d), 7 (b), 8 (d), 9 (d), 10 (c), 11 (d), 12 (b), 13 (a), 14 (c), 15 (b), 16 (b).

ANSWERS TO MULTIPLE CHOICE QUESTIONS – SET B

1 (d), 2 (a), 3 (b), 4 (a), 5 (c), 6 (a), 7 (c), 8 (b), 9 (b), 10 (c), 11 (b), 12 (c), 13 (d), 14 (b), 15 (c).

ANSWERS TO ADDITIONAL QUESTIONS

1 (a) 63; (b) 54

2 +1, –1, –2, 0

3 52.5, 30, 37.5, 55

4 Z's are a standard score with M= 0 and SD = 1

5 B

6 120, 130, 140

7 Score is above M

8 55, 5

9 Afternoon

10 81.5 approx

11 .16, .975, .95

12 100–130, 150–250

13 34.13%

14 .16, .16

15 large

16 accountancy best; applied research worst.

ANSWERS TO QUESTIONS IN CHAPTER 8

Qu. 8.2	(a) 46;	(b) 70;	(c) 50
Qu. 8.3	(a) 0.34 approx	(b) 680 approx	
Qu. 8.4	(a) .95 approx	(b) 680 approx	
Qu. 8.8	(a) .34 (b) .95	(c) .34	(d) .50
Qu. 8.9	(a) 25	(b) 950	
Qu. 8.10	100		
Qu. 8.11	(a) 100,	(b) 140,	(c) 80–120