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Class: B.Ed. II Semester

Paper: BED 202- Assessment of Learning

Unit: 4

Topic: Measures of Position

Learning Objectives

After studying this unit, the learner will be able to:

- **Explain the meaning** of Measures of Position and their role in educational statistics.

- **Identify different types** of measures of position, namely Quartiles, Deciles and Percentiles.

- **Define Quartiles** (Q_1, Q_2, Q_3), Deciles (D_1–D_9) and **Percentiles** (P_1–P_{99}) with examples.

- **Calculate quartiles** for ungrouped and grouped data accurately.

- **Compute Deciles and Percentiles** for educational data such as test scores and achievement records.

- **Interpret positional values** to determine a student's relative standing in a group.

- **Compare learners' performance** using Quartiles, Deciles and Percentiles.

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Learning Objectives

After studying this unit, the learner will be able to:

- **Distinguish between central tendency and position** and explain how measures of position complement measures of central tendency.

- **Apply measures of position** in grading, ranking, selection and classification of students.

- **Use percentile ranks** to explain competitive examinations and standardized test results.

- **Analyze educational data** by locating high achievers, average learners and low achievers through positional measures.

- **Develop statistical reasoning skills** by drawing conclusions from Quartile, Deciles and Percentile values.

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Measures of Position

Meaning

➢ Measures of position or location is a **'descriptive statistic'** that describe the relative position of a single value in relation to other values in a data set.

➢ This is completely based on **'ordinal scale'** means calculated on arranged data. (may be arranged in ascending or descending order but mostly in ascending order)

Type's:

1. **Median ∼ Fractile** (mostly measures of position are the extensive form of median)

2. **Quartiles**

3. **Deciles**

4. **Percentiles** or **Centile and Percentiles Rank**

5. **Standard Score** (Z score)

6. **Five Number Summary** (Max Value, Min Value, Median, First Quartile, Third Quartile)

7. **Quintiles** (Descending order)

Measures of Position

1. Median ∼ Fractile (50%)

Single point or **value** that divided the arranged data into **two equal parts** means 50% value is less than it and 50% value is greater than it.

$$50\% \text{ data} \qquad M_d \qquad 50\% \text{ data}$$

2. Quartiles (25%)

- The quartiles are **three separator points** or **values** that divided the arranged data into **four equal** parts.

- The **first quartile** is denoted Q_1 and has 25% of the values less than it and 75% of the values greater than it.

- The **second quartile** is denoted Q_2 and it same as the median and has 50% of the values less than it and 50% of the values greater than it.

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Measures of Position

- The third quartile is denoted **Q_3** and has 75% of the values less than it and 25% of the values greater than it.

$$25\% \qquad Q_1 \qquad 25\% \qquad Q_2 \qquad 25\% \qquad Q_3 \qquad 25\%$$

Procedure for finding

a) For Ungrouped data *(small data)*

i) First arranged the data in ascending order and then find N.

ii) For $Q_1 = \dfrac{N}{4}$ th score

iii) For $Q_2 = \dfrac{N}{2}$ th score

iv) For $Q_3 = \dfrac{3N}{4}$ th score

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b) For Grouped data (large data)

i) First arranged the data in ascending order.

ii) For Q_1

$$Q_1 = L + \frac{\frac{N}{4} - cfB}{f} \times i$$

iii) For Q_2

$$Q_2 = L + \frac{\frac{N}{2} - cfB}{f} \times i$$

iv) For Q_3

$$Q_3 = L + \frac{\frac{3N}{4} - cfB}{f} \times i$$

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Measures of Position

Examples:

1. Find the Q_1 and Q_3 of fallowing dataset.

    12, 3, 9, 23, 5, 10, 19

Solution:

First arrange the data in ascending order

    3, 5, 9, 10, 12, 19, 23   N=7

$$Q_1 = \frac{N}{4} \text{ th score}$$

$$Q_1 = \frac{7}{4} \text{ th score}$$

$$Q_1 = 1.75 \text{ th score}$$

$$Q_1 = 3 + .75(5-3)$$

$$Q_1 = 3 + .75 \times 2$$

Q_1 = 4.5 (ans)

$$\text{For } Q_3 = \frac{3N}{4} \text{ th score}$$

$$Q_3 = \frac{3 X 7}{4} \text{ th score}$$

$$Q_3 = \frac{21}{4} \text{ th score}$$

$$Q_3 = 5.25 \text{ th score}$$

$$Q_3 = 12 + .25(19-12)$$

$$Q_3 = 12 + 1.75$$

$Q_3 = 13.75$ (ans)

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Measures of Position

2. Find the Q_1 and Q_3 of fallowing data.

C.I.	10-19	20-29	30-39	40-49	50-59	60-69	70-79
f	2	5	15	17	11	4	2

Solution:

C.I.	f	Cf
70-79	2	56
60-69	4	54
50-59	11	50
40-49	17	39
30-39	15	22
20-29	5	7
10-19	2	2
i = 10	N = 56	

$$Q_1 = L + \frac{\frac{N}{4} - cfB}{f} \times i$$

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Measures of Position

Quartile class = $\dfrac{56}{4}$ = 14 (30-39)

L = 29.5 cf_B = 7, f = 15, i = 10

Putting these values in formula-

$$Q_1 = 29.5 + \frac{14\ -7}{15} \times 10$$

$$Q_1 = 29.5 + 4.67$$

Q_1 = 34.17

For Q_3

Quartile class – (50-59)

L = 49.5 cf_B = 39 f = 11 i = 10

Putting these values in formula-

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Measures of Position

$$Q_3 = L + \frac{\frac{3N}{4} - cfB}{f} \times i$$

$$Q_3 = 49.5 + \frac{42 - 39}{11} \times 10$$

$$Q_3 = 49.5 + 2.73$$

$Q_3 = 52.23$

So first quartile of given data is = **34.17** and second quartile of data is = **52.23**

Self Assessment Questions

1. Find the Q_1, Q_2 and Q_3 of given dataset.

25, 31, 44, 35, 36, 24, 39, 20, 15, 18, 30

2. Find the Q_1, Q_2 and Q_3 of given dataset.

C.I.	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54
f	4	8	12	16	12	10	5	3

3. Find the Q_1, Q_2 and Q_3 of given dataset.

C.I.	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90
f	3	7	12	16	13	8	4	2

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Measures of Position

3. Deciles (10%)

➤ The deciles are **nine separator points** or **values** that divided the arranged data into **ten equal** parts.

➤ It's denoted by D_k means $D_1, D_2, ...D_9$.

D_1　　　　　　　　　　　D_5　　　　　　　　D_9

Procedure for Calculation:

a) For Ungrouped data (small data)

i) First arranged the data in ascending order and then find N.

ii) For $D_k = \dfrac{NK}{10}$ th score

iii) For $D_2 = \dfrac{2N}{10}$ th score

iv) For $D_5 = \dfrac{5N}{10}$ th score

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b) For Grouped data (large data)

i) First arranged the data in ascending order.

ii) For D_1

$$D_1 = L + \frac{\frac{N}{10} - cfB}{f} \times i$$

iii) For D_5

$$D_5 = L + \frac{\frac{5N}{10} - cfB}{f} \times i$$

iv) For D_9

$$D_9 = L + \frac{\frac{9N}{10} - cfB}{f} \times i$$

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Measures of Position

Examples:

1. Find the D_3 and D_7 of fallowing dataset.

    12, 3, 9, 23, 5, 10, 19

Solution:

First arrange the data into ascending order

    3, 5, 9, 10, 12, 19, 23   N=7

For D_3 :

$$D_3 = \frac{3N}{10} \text{ th score}$$

$$D_3 = \frac{3X7}{10} \text{ th score}$$

$$D_3 = \frac{21}{10} \text{ th score}$$

$$D_3 = 2.1 \text{ th score}$$

$$D_3 = 5 + .1(9\text{-}5)$$

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$$D_3 = 5 + 0.4$$

$$\mathbf{D_3 = 5.4}$$

For D_7

$$D_7 = \frac{7N}{10} \text{ th score}$$

$$D_7 = \frac{7X7}{10} \text{ th score}$$

$$D_7 = \frac{49}{10} \text{ th score}$$

$$D_7 = 4.9 \text{th score}$$

$$D_7 = 10 + .9(12\text{-}10)$$

$$D_7 = 10 + 2.8$$

$$\mathbf{D_7 = 12.8}$$

So D3 = 5.4 and D7 = 12.8 of given data.

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Self Assessment Questions

1. Find the D_3, D_5 and D_7 of given dataset.

25, 31, 44, 35, 36, 24, 39, 20, 15, 18, 30

2. Find the D_1, D_2 and D_4 of given dataset.

C.I.	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90
f	3	7	12	16	13	8	4	2

3. Find the D_6, D_8 and D_9 of given dataset.

C.I.	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54
f	4	8	12	16	12	10	5	3

Measures of Position

4. Percentiles or Centiles (1%)

➤ Percentiles are **99 separator points** or **values** (P_1 to P_{99}) which divided the arranged scores into **100 equal parts**.

➤ Percentile is **a score** or **value** in a arranged dataset that indicate a specific percentage of scores falls below that score.

➤ It's denoted by **P_k** (P_1 to P_{99}).

5. Percentile Rank

Percentile rank is a **percentage of scores** (but not expressed in %) in a arranged dataset that is lower or equal to specific given score. (प्राप्तांको का वह प्रतिशत जो एक दिये गये प्राप्तांक से कम अथवा नीचे है)

Note: Both concept are given common meaning in different ways.

Measures of Position

Procedure for Calculation of Percentiles:

a) For Ungrouped data (small data)

i) First arranged the data in ascending order and then find N.

ii) For $P_k = \dfrac{NK}{100}$ th score or $P_k = (\dfrac{NK}{100} + .5)$ **th score**

iii) For $P_{25} = \dfrac{25N}{100}$ th score or $P_{25} = (\dfrac{25N}{100} + .5)$ th score

iv) For $P_{75} = \dfrac{75N}{100}$ th score or $P_{75} = (\dfrac{75N}{100} + .5)$ th score

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Measures of Position

b) For Grouped data (large data)

i) First arranged the data in ascending order.

ii) For P_k

$$P_k = L + \frac{\frac{NK}{100} - cfB}{f} \times i$$

iii) For P_{25}

$$P_{25} = L + \frac{\frac{25N}{100} - cfB}{f} \times i$$

iv) For P_{75}

$$P_{75} = L + \frac{\frac{75N}{100} - cfB}{f} \times i$$

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Measures of Position

Examples:

1. Find the P_{25} and P_{75} of fallowing dataset.

   12, 3, 9, 23, 5, 10, 19

Solution:

First arrange the data in ascending order

   3, 5, 9, 10, 12, 19, 23   N = 7

$$P_k = (\frac{NK}{100} + .5)\text{th score}$$

For P_{25}

$$P_{25} = (\frac{7 \times 25}{100} + .5)\text{th score}$$

$$P_{25} = (\frac{175}{100} + .5)\text{th score}$$

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Measures of Position

P_{25} = (1.75 + .5)th score

P_{25} = 2.25 th score

P_{25} = 5 + 0.25(9-5)

P_{25} = 6

For P_{75}

$P_{75} = (\frac{7 \times 75}{100} + .5)$th score

$P_{75} = (\frac{525}{100} + .5)$th score

$P_{75} = (5.25 + .5)$th score

$P_{75} = 5.75$ th score

$P_{75} = 12 + 0.75(19 - 12)$

$P_{75} = 12 + 5.25$

$P_{75} = 17.25$

So P_{25} and P_{75} values of given data are sequentially 6 and 17.25.

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Measures of Position

2. Find the P_{75} fallowing data.

C.I.	10-19	20-29	30-39	40-49	50-59	60-69	70-79
f	2	5	6	10	8	4	3

Solution:

C.I.	f	Cf
70-79	3	38
60-69	4	35
50-59	8	31
40-49	10	23
30-39	6	13
20-29	5	7
10-19	2	2
i = 10	N = 38	

$$P_{75} = L + \frac{\frac{75N}{100} - cfB}{f} \times i$$

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Measures of Position

Percentile class for P$_{75}$: $\dfrac{NK}{100}$ $=$ $\dfrac{38X75}{100}$ $= 28.50 = (50\text{-}59)$

L = 49.5   Cf$_B$ = 23   f = 8   i = 10

Putting these values in formula

$$P_{75} = 49.5 + \frac{28.50 - 23}{8} \times 10$$

$$P_{75} = 49.5 + \frac{55}{8}$$

$$P_{75} = 49.5 + 6.88$$

$$\mathbf{P_{75} = 56.38}$$

So P$_{75}$ of given data is 56.38.

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Self Assessment Questions

1. Find the P_{35}, P_{55} and P_{70} of given dataset.

25, 31, 44, 35, 36, 24, 39, 20, 15, 18, 30, 27

2. Find the P_{10}, P_{25} and P_{75} of given dataset.

C.I.	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90
f	3	7	9	14	11	8	4	2

3. Find the P_{60}, P_{80} and P_{90} of given dataset.

C.I.	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54
f	4	9	12	18	11	8	5	3

Relationship between Median, Quartiles, Deciles and Percentiles

Median	Quartiles	Deciles	Percentiles
		D_9	P_{90}
		D_8	P_{80}
		D_7	P_{70}
	Q_3		P_{75}
		D_6	P_{60}
M_d	Q_2	D_5	P_{50}
		D_4	P_{40}
		D_3	P_{30}
	Q_1		P_{25}
		D_2	P_{20}
		D_1	P_{10}

(i) $M_d = Q_2 = D_5 = P_{50}$ (ii) $Q_1 = P_{25}$ (iii) $Q_3 = P_{75}$

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Measures of Position

6. Standard Score (Z score)

➤ The standard **score** (often called the **z-score**) shows the distance of a score from the mean in term of standard deviation.

➤ Determined, how many SD units of raw score is **greater or less** than **mean** or **near/for from mean**.

➤ Z-score value is founded by subtracting the mean from raw score then divided by the standard deviation.

$$\text{Z Score} = \frac{X - M}{SD}$$

Here, how to interpret z-scores:

1. If z-score less than 0 then represents, that score is less than mean.

2. If z-score greater than 0 then represents, that score is greater than mean.

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3.   If z-score equal to 0 then represents, that score is equal to mean.

4.   If z-score equal to +1 then represents, that score is 1 SD greater than mean. (same as in case of +2 and +3 z-score)

5.   If z-score equal to -1 then represents, that score is 1 SD less than mean. (same as in case of -2 and -3 z-score)

Note:

Z-Score is **only a single standard score** that is used both as descriptive Statistics and Inferential Statistics.

Descriptive: describes exactly where each individual score is located in term of SD.

Inferential: determines whether a specific sample is representative of it's population or not.

Measures of Position

7. Quintiles (पंचमक) : 20%

➢ The quintiles are **four separator points** or **values** that divided arranged data into **five equal parts** in **backward nature**, here backward means data arranged in descending order (high to low).

➢ It's denoted by R_1, R_2, R_3 and R_4.

➢ In quintile, best results lie on first quintile but in quartile, best result in third quartile.
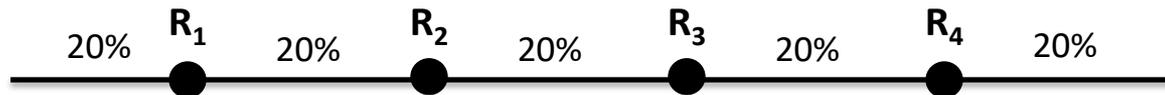
➢ Calculation of quintiles same as quartiles or percentiles with base 5.

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Measures of Position

Note:

1.   All measures of position are possible to represents as graphical form.

2.   With help of **Ogive graph** (percentage cumulative frequency curve) we can calculated **Percentiles, Percentile Ranks, Deciles, Quartiles, Quintiles and Median** in easy way but condition is that construction of Ogive has done accurately.

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Learning Outcomes

On successful completion of this unit, the B.Ed. student will be able to:

- **Describe** the concept and significance of *Measures of Position* in educational statistics.

- **Identify and classify** Quartiles, Deciles, and percentiles used in educational data analysis.

- **Compute** Quartiles, Deciles, and percentiles for ungrouped and grouped data sets correctly.

- **Interpret positional values** to explain a learner's relative position within a group.

- **Differentiate** between central tendency and positional measures using suitable examples.

- **Apply measures of position** in grading, ranking, selection and placement of students.

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Learning Outcomes

On successful completion of this unit, the B.Ed. student will be able to:

- **Analyze examination results** using Quartiles, Deciles and percentiles.

- **Use percentile ranks** to interpret results of standardized and competitive examinations.

- **Evaluate student's performance distribution** to identify high, average and low achievers.

- **Demonstrate statistical reasoning skills** while drawing conclusions from positional measures.

- **Relate measures of position** to classroom assessment, guidance and counselling practices.

- **Prepare simple statistical reports** using Quartiles, Deciles and Percentiles for educational purposes.

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Self Assessment Questions
(Question Bank)

1. **Measures of position are used to determine the _____ of an observation in a distribution.**

   a) Total value

   b) Central value

   c) Relative position

   d) Variability

2. **Which of the following is a measure of position?**

   a) Mean

   b) Median

   c) Quartile

   d) Standard deviation

3. **Quartiles divide a distribution into how many equal parts?**

   a) Two

   b) Three

   c) Four

   d) Ten

4. **Measures of position help in identifying:**

   a) Total performance

   b) Variability of scores

   c) Relative standing of learners

   d) Reliability of tests

5. **Which of the following is a positional measure used to divide data into ten groups?**

   a) Quartile

   b) Percentile

   c) Decile

   d) Median

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Self Assessment Questions
(Question Bank)

6. **Which measure of position is most suitable for reporting results of large-scale tests?**

   a) Quartile

   b) Decile

   c) Percentile

   d) Median

7. **Measures of position are especially important in educational evaluation for:**

   a) Computing mean scores

   b) Classification and selection of students

   c) Measuring test reliability

   d) Determining syllabus coverage

8. **Students below the first quartile are generally considered as:**

   a) High achievers

   b) Average achievers

   c) Low achievers

   d) Top performers

9. **The second quartile (Q_2) is also known as the:**

   a) Mean

   b) Mode

   c) Median

   d) Range

10. **Deciles divide a frequency distribution into:**

    a) 4 equal parts

    b) 5 equal parts

    c) 10 equal parts

    d) 100 equal parts

11. **Percentile ranks are commonly used in**:

    a) Classroom teaching

    b) Lesson planning

    c) Competitive examinations

    d) Curriculum development

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Self Assessment Questions
(Question Bank)

12. **The 75th percentile corresponds to:**

    a) Q_1

    b) Q_2

    c) Q_3

    d) D_7

13. **Measures of position are most useful for:**

    a) Finding average achievement

    b) Measuring dispersion

    c) Ranking students

    d) Computing total scores

14. **Percentiles divide the data into how many equal parts?**

    a) 10

    b) 20

    c) 50

    d) 100

15. **The position of the first quartile in ungrouped data is given by:**

    a) N/2

    b) N/4

    c) 3N/4

    d) N/10

16. **How many deciles are there in a distribution?**

    a) 4

    b) 5

    c) 9

    d) 10

17. **The third quartile (Q_3) indicates that _____ percent of observations lie below it.**

    a) 25

    b) 50

    c) 75

    d) 90

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Thank You for Reading

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