

Cumulative Frequency, Variance and Standard Deviation Calculations

Professional lesson note for classroom use

SUBJECT
mathematics

CLASS
ss2

FORMAT
Traditional Nigerian

DATE
2026-06-02

DURATION
40 minutes

AGE OF LEARNERS
13years

SUB-TOPIC
cumulative
frequency, variance and
standard deviation
calculations

REFERENCE BOOK

Reference Book: New general mathematics book 2

MAIN AIM

To enable students to understand and calculate cumulative frequency, variance, and standard deviation from grouped data sets using accurate methods and systematic working.

SUBSIDIARY AIMS

- To develop students' ability to construct cumulative frequency tables from raw data
- To teach students the formula and method for calculating variance and standard deviation
- To help students recognise and correct common errors in statistical calculations
- To enable students to interpret and apply these measures in practical contexts

OBJECTIVES

- Students will be able to construct a cumulative frequency table from a frequency distribution
- Students will calculate variance using the formula: $\text{Variance} = \frac{\sum(x - \text{mean})^2}{n}$
- Students will calculate standard deviation as the square root of variance
- Students will identify and correct errors in working and final answers
- Students will explain the method used in solving variance and standard deviation problems

PREVIOUS KNOWLEDGE

- Understanding of frequency distributions and grouped data
- Knowledge of mean, median, and mode calculations
- Ability to work with summation notation (Σ)
- Familiarity with squared numbers and square roots
- Basic understanding of what variance and standard deviation measure

MATERIALS

- Chalkboard and chalk
- Printed frequency distribution tables (one per student)
- Calculators (one per student or pair)
- Graph paper for plotting cumulative frequency curves

KEY VOCABULARY

Cumulative Frequency: the running total of frequencies, adding each frequency to the sum of all previous frequencies

Variance: a measure of how spread out the data is from the mean, calculated as the average of squared deviations from the mean

Standard Deviation: the square root of variance, showing the typical distance of data points from the mean

Method: the ordered step-by-step process for solving a problem

- Worked example sheets
- Practice problem cards

Working: the detailed steps shown before reaching the final answer

Deviation: the difference between each data value and the mean

VOCABULARY NOTES

cumulative frequency, variance and standard deviation calculations

Cumulative Frequency, variance And Standard Deviation Calculations should be taught through clear method, accurate working, and repeated checking of steps.

Method

Method is the ordered way of solving or explaining the task step by step.

LESSON STRUCTURE

INTRODUCTION (5 MINUTES)

- Greet students and write the lesson title on the board: Cumulative Frequency, Variance and Standard Deviation Calculations
- Ask: What do we use to measure how spread out data is? (Listen for responses about range, variance, standard deviation)
- State the learning objectives clearly: By the end of this lesson, you will be able to calculate cumulative frequency, variance, and standard deviation from data sets
- Explain that these calculations help us understand data better and are used in real situations like test scores, heights, and quality control

CUMULATIVE FREQUENCY EXPLANATION (8 MINUTES)

- Write on the board: Definition - Cumulative Frequency is the running total of all frequencies up to a certain point
- Draw a simple frequency table on the board with class intervals and frequencies
- Example: Class 0-10, 10-20, 20-30, 30-40 with frequencies 5, 8, 12, 10
- Show step-by-step how to build the cumulative frequency column:
 - First class: 5 (just the first frequency)
 - Second class: $5 + 8 = 13$
 - Third class: $13 + 12 = 25$
 - Fourth class: $25 + 10 = 35$
- Emphasise: Each cumulative frequency is the sum of all frequencies up to and including that class
- Explain that cumulative frequency helps us find medians and quartiles, and can be plotted as an ogive curve

GUIDED PRACTICE ON CUMULATIVE FREQUENCY (5 MINUTES)

- Give students a new frequency table: Class 0-5, 5-10, 10-15, 15-20 with frequencies 3, 7, 9, 6
- Work through the first two cumulative frequencies together on the board
- Ask students to complete the remaining cumulative frequencies on their own papers
- Check answers: 3, 10, 19, 25
- Ask one student to explain how they got 19 (answer: 10 + 9)
- Correct any errors and reinforce the method

VARIANCE AND STANDARD DEVIATION EXPLANATION (10 MINUTES)

- Write on the board: Variance measures how far data points are spread from the mean
- Write the formula: Variance (σ^2) = $\Sigma(x - \text{mean})^2 / n$
- Explain each part: x is each data value, mean is the average, n is the number of values
- Write: Standard Deviation (σ) = $\sqrt{\text{Variance}}$
- Explain: Standard deviation is easier to interpret because it's in the same units as the original data
- Work through a simple example with ungrouped data first: Data set: 2, 4, 6, 8, 10
- Step 1: Find the mean = $(2+4+6+8+10)/5 = 30/5 = 6$
- Step 2: Find deviations from mean: -4, -2, 0, 2, 4
- Step 3: Square the deviations: 16, 4, 0, 4, 16
- Step 4: Sum the squared deviations: $16+4+0+4+16 = 40$
- Step 5: Divide by n: $40/5 = 8$ (this is variance)
- Step 6: Take the square root: $\sqrt{8} = 2.83$ (this is standard deviation)
- Emphasise: We square the deviations to avoid negative numbers cancelling out positive ones

**WORKED EXAMPLE:
GROUPED DATA (7
MINUTES)**

- Present a grouped frequency table on the board:
- Class: 10-20, 20-30, 30-40, 40-50
- Frequency: 4, 6, 8, 2
- Midpoint: 15, 25, 35, 45
- Step 1: Calculate the mean using midpoints
- Mean = $(15 \times 4 + 25 \times 6 + 35 \times 8 + 45 \times 2) / (4 + 6 + 8 + 2)$
- Mean = $(60 + 150 + 280 + 90) / 20 = 580 / 20 = 29$
- Step 2: Calculate deviations from mean for each midpoint
- $15 - 29 = -14$, $25 - 29 = -4$, $35 - 29 = 6$, $45 - 29 = 16$
- Step 3: Square the deviations
- 196, 16, 36, 256
- Step 4: Multiply each squared deviation by its frequency
- $196 \times 4 = 784$, $16 \times 6 = 96$, $36 \times 8 = 288$, $256 \times 2 = 512$
- Step 5: Sum these products: $784 + 96 + 288 + 512 = 1680$
- Step 6: Divide by total frequency to get variance
- Variance = $1680 / 20 = 84$
- Step 7: Take square root for standard deviation
- Standard Deviation = $\sqrt{84} = 9.17$ (to 2 d.p.)
- Write on board: Always show your working clearly. Check each step before moving to the next.

**GUIDED PRACTICE
AND ERROR
CORRECTION (5
MINUTES)**

- Give students a new grouped data problem with a frequency table
- Ask them to work in pairs and calculate the variance and standard deviation
- Circulate and check their working as they go
- Identify common errors: forgetting to multiply by frequency, using wrong mean, arithmetic mistakes
- Bring the class together and work through the solution on the board
- Ask: What would happen if we forgot to multiply by frequency? (Answer: We would get the wrong variance)
- Correct any misconceptions immediately

TEACHING EXPLANATION

- Cumulative frequency is built by adding each frequency to all the frequencies before it. This creates a running total that increases as you move down the table. The last cumulative frequency should equal the total number of observations.
- Variance measures spread by looking at how far each data point is from the average. We square the deviations so that negative and positive differences don't cancel each other out. The larger the variance, the more spread out the data is.
- Standard deviation is the square root of variance. It's useful because it's in the same units as the original data, making it easier to interpret. For example, if data is in centimetres, standard deviation is also in centimetres.
- When working with grouped data, we use the class midpoint to represent all values in that class. This is an approximation, but it's the standard method for grouped data.
- Common errors happen when students skip steps, use the wrong formula, or make arithmetic mistakes. Always show your working and check each calculation before moving on.

TEXTBOOK-STYLE WORKED NOTES

Example 1: Cumulative Frequency Table

A shop records the number of customers per hour over 20 hours. The frequency distribution is: 0-10 customers (3 hours), 10-20 customers (7 hours), 20-30 customers (6 hours), 30-40 customers (4 hours). Build the cumulative frequency table. Solution: Cumulative frequencies are 3, 10, 16, 20. The last value (20) equals the total number of observations, confirming our work is correct.

Example 2: Variance and Standard Deviation

Calculate the variance and standard deviation for the data set: 5, 7, 9, 11, 13. Mean = $(5+7+9+11+13)/5 = 45/5 = 9$. Deviations: -4, -2, 0, 2, 4. Squared deviations: 16, 4, 0, 4, 16. Sum of squared deviations: 40. Variance = $40/5 = 8$. Standard Deviation = $\sqrt{8} = 2.83$ (to 2 d.p.). This tells us that, on average, data points are about 2.83 units away from the mean.

WORKED EXAMPLES

- Worked Example 1: Given the frequency table with classes 0-5 (freq 2), 5-10 (freq 5), 10-15 (freq 8), 15-20 (freq 5). Build cumulative frequency: 2, 7, 15, 20. Check: $2+5=7$, $7+8=15$, $15+5=20$. ✓
- Worked Example 2: For grouped data with midpoints 10, 20, 30, 40 and frequencies 3, 5, 7, 5. Mean = $(10 \times 3 + 20 \times 5 + 30 \times 7 + 40 \times 5) / (3+5+7+5) = (30+100+210+200) / 20 = 540 / 20 = 27$. Deviations: -17, -7, 3, 13. Squared: 289, 49, 9, 169. Products with frequency: 867, 245, 63, 845. Sum = 2020. Variance = $2020 / 20 = 101$. Standard Deviation = $\sqrt{101} = 10.05$ (to 2 d.p.)

BOARD SUMMARY

- CUMULATIVE FREQUENCY, VARIANCE AND STANDARD DEVIATION CALCULATIONS
- 1. CUMULATIVE FREQUENCY
 - - Definition: Running total of frequencies
 - - Method: Add each frequency to the sum of all previous frequencies
 - - Check: Last cumulative frequency = total number of observations
- 2. VARIANCE
 - - Formula: $\sigma^2 = \frac{\sum(x - \text{mean})^2}{n}$
 - - Steps: Find mean → Calculate deviations → Square deviations → Sum squared deviations → Divide by n
 - - For grouped data: Use class midpoints
- 3. STANDARD DEVIATION
 - - Formula: $\sigma = \sqrt{\text{Variance}}$
 - - Interpretation: Average distance of data from the mean
 - - Same units as original data
- KEY REMINDERS:
 - - Always show your working step by step
 - - Check arithmetic at each stage
 - - For grouped data, multiply squared deviations by frequency before summing
 - - Square root of variance gives standard deviation

TEACHER PROCEDURE

1. Begin by writing the lesson title on the board and stating the three learning objectives clearly

LEARNER ACTIVITIES

- Students copy the lesson objectives and board summary into their notebooks

2. Ask students what they already know about measuring data spread to activate prior knowledge
 3. Introduce cumulative frequency with a simple 4-class example, building the table step-by-step on the board
 4. Explain that cumulative frequency is a running total, showing how many observations fall up to each class boundary
 5. Introduce the variance formula on the board and explain each component: x , mean, squared deviations, n
 6. Work through a simple ungrouped data example (5 values) showing all 6 steps clearly
 7. Present a grouped data example with a frequency table, using class midpoints
 8. Calculate the mean using midpoints and frequencies, showing the calculation on the board
 9. Work through variance calculation step-by-step: deviations, squaring, multiplying by frequency, summing, dividing by n
 10. Calculate standard deviation as the square root of variance
 11. Give students a new grouped data problem to work on in pairs
 12. Circulate and check their working, identifying and correcting errors immediately
 13. Bring the class together and work through the solution, highlighting where errors commonly occur
 14. Ask students to explain the method used and what each step represents
 15. Summarise the key points and write the board summary for students to copy
- Students work through the guided cumulative frequency practice problem on their own papers
 - Students check their cumulative frequency answers against the board solution
 - Students work in pairs on a grouped data problem, calculating variance and standard deviation
 - Students explain to their partner how they calculated the mean from grouped data
 - Students identify and correct errors in a worked example with deliberate mistakes
 - Students complete an independent practice problem on variance and standard deviation
 - Students present their working to the class and explain each step

ACTIVITIES

- Cumulative Frequency Table Building: Students are given raw frequency data and must construct a cumulative frequency table, checking that the final value equals the total frequency
- Variance and Standard Deviation Calculation: Students work through a complete grouped data problem, calculating mean, variance, and standard deviation with all steps shown
- Error Identification and Correction: Students are given worked examples with deliberate errors and must identify where the mistake occurred and correct it
- Paired Problem Solving: Students work in pairs on a new problem, with one student calculating and the other checking the working
- Data Interpretation: Students calculate variance and standard deviation for two different data sets and compare what these measures tell us about the spread

EVALUATION QUESTIONS

- What is cumulative frequency and how do you build a cumulative frequency table?
- Why do we square the deviations when calculating variance?
- A student calculated variance as 50 but forgot to multiply the squared deviations by their frequencies. What error did they make?
- Given the data set 4, 6, 8, 10, 12, calculate the mean, variance, and standard deviation. Show all your working.
- For grouped data with classes 0-10, 10-20, 20-30 and frequencies 5, 8, 7, calculate the cumulative frequency table and the mean using class midpoints.
- Why is standard deviation more useful than variance when interpreting data spread?
- A student calculated the last cumulative frequency as 18, but the total frequency is 20. What does this tell you about their work?
- Explain the difference between variance and standard deviation in terms of units and interpretation.

ASSESSMENT

- Checking student calculations during paired practice to identify errors in variance and standard deviation calculations
 - Review of student notebooks to ensure all steps are shown clearly and working is accurate
 - Questioning students about why we square deviations and what standard deviation represents
 - Marking of independent practice problems using a checklist: correct method, accurate arithmetic, clear working, correct final answer
 - Exit ticket: Students write down one thing they learned and one thing they found difficult about the lesson
- For students who struggle: Provide a partially completed cumulative frequency table and ask them to fill in the missing values. Use ungrouped data (5-6 values) for variance and standard deviation calculations. Provide a step-by-step checklist to follow.
 - For students working at expected level: Give complete grouped data problems requiring all calculations. Ask them to interpret what the variance and standard deviation tell us about the data.
 - For advanced students: Ask them to compare variance and standard deviation for two different data sets and explain which has greater spread. Challenge them to calculate these measures for a larger grouped data set (6-8 classes). Ask them to explain why we divide by n rather than $(n-1)$ in this context.

DIFFERENTIATION / SUPPORT

HOMEWORK

- Complete a grouped frequency table with 5 classes and calculate the cumulative frequency for each class
- Given a frequency distribution, calculate the mean, variance, and standard deviation, showing all working
- Collect data from your class (e.g., heights, test scores) and calculate cumulative frequency, variance, and standard deviation
- Correct the errors in a worked example where variance and standard deviation have been calculated incorrectly
- Write a short explanation of what variance and standard deviation tell us about a data set, using an example

SUMMARY

This lesson teaches SS2 students how to calculate cumulative frequency, variance, and standard deviation from grouped data. The lesson begins with cumulative frequency, showing students how to build a running total of frequencies. Students then learn the variance formula and work through the six-step method: finding the mean, calculating deviations, squaring deviations, multiplying by frequency, summing, and dividing by the total frequency. Standard deviation is introduced as the square root of variance. Throughout the lesson, students work through guided examples, identify and correct common errors, and complete independent practice problems. The focus is on clear method, accurate working, and step-by-step checking. By the end of the lesson, students should be able to construct cumulative frequency tables and calculate variance and standard deviation for grouped data sets, showing all their working clearly.

SUGGESTED TEACHING VISUALS

- graph of calculated cumulative frequency if part of work

TEACHER REFLECTION

- Did students understand the concept of cumulative frequency as a running total, or did some struggle with the addition process?
- Were students able to apply the variance formula correctly, or did they make errors in squaring deviations or multiplying by frequency?
- Did students show all their working, or did some skip steps and make errors as a result?
- Which common errors appeared most frequently, and do these need to be addressed in the next lesson?
- Did the worked examples help students understand the method, or do I need to use different examples next time?
- Were students able to explain why we calculate variance and standard deviation, or do they see these as just procedures to follow?
- Did the 40-minute timeframe allow enough time for guided practice and error correction, or do I need to adjust the pacing?
- Which students need additional support with these calculations, and which are ready for more challenging problems?