Histograms: Reading and Interpreting Grouped Data

Professional lesson note for classroom use

SUBJECT	CLASS	FORMAT	DATE
Mathematics	ss2	TKT / TESOL	-

DURATION	AGE OF LEARNERS	SUB-TOPIC
40 minutes	-	Histograms

MAIN AIM

To enable learners understand the meaning of histograms and apply the correct method to read, interpret, and construct histograms from grouped data.

SUBSIDIARY AIMS

- Understand what histograms are and how they differ from bar charts
- Learn the rule and method for constructing histograms with class intervals
- Develop accuracy in reading frequency density from histograms
- Apply checking procedures to verify histogram construction and interpretation

OBJECTIVES

- State the rule and method for constructing a histogram with class intervals correctly
- Work through the steps for reading and interpreting a histogram in the correct order
- Solve a similar histogram task and check the answer using the method taught

PREVIOUS KNOWLEDGE

- Learners should be secure with frequency tables and grouped data
- Learners should understand class intervals and frequency
- Learners should be able to plot points on a graph and draw axes

MATERIALS

- Whiteboard and markers
- Ruler and pencil for drawing axes
- Graph paper or squared paper
- Worked example sheet (teacher-prepared)
- Practice task sheet for learners
- Calculator (optional, for frequency density calculations)

KEY VOCABULARY

- Histogram: a graph used to display continuous data grouped into class intervals, where the height of each bar represents frequency density
- Frequency density: the frequency divided by the class width, calculated as Frequency ÷ Class Width
- Class interval: a range of values used to group continuous data, such as 10-20, 20-30
- Class width: the size of each class interval, calculated as upper boundary minus lower boundary
- Frequency: the number of data values that fall within each class interval
- Method: the ordered way of solving or explaining the task step by step
- Working: the steps taken before the final answer is reached
- Check: reviewing the work to confirm that the steps and final response are correct

VOCABULARY NOTES

Histograms

Histograms 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 AND AIM STATEMENT	• Begin by showing learners a simple histogram on the board or a visual example • Ask: 'What do you notice about this graph? How is it different from a bar chart we have seen before?' • Listen for responses about bars touching, continuous data, and frequency density • State the lesson aim clearly: 'Today we are learning how to read, interpret, and construct histograms. We will learn the method step by step, work through examples together, and check our answers.'
EXPLANATION OF HISTOGRAMS AND KEY VOCABULARY	• Define histogram: 'A histogram is a graph that shows continuous data grouped into class intervals. Unlike a bar chart, the bars touch each other because the data is continuous.' • Explain class intervals: 'We group data into ranges called class intervals. For example, heights might be grouped as 150-160 cm, 160-170 cm, and so on. The class width is the size of each interval.' • Introduce frequency density: 'In a histogram, the height of each bar is not the frequency itself. Instead, we use frequency density. The rule is: Frequency Density = Frequency ÷ Class Width. This is important because it allows us to compare groups of different sizes fairly.' • Write the formula on the board and ask learners to copy it into their books • Explain why this matters: 'If we just used frequency, a wider class interval would always look taller, even if it had fewer data values per unit. Frequency density fixes this problem.'

TEACHER-MODELLED WORKED EXAMPLE

- Present a complete worked example on the board. Use this scenario:
- Example: A teacher measured the heights of 40 students. The data is grouped as follows:
- 140-150 cm: 8 students
- 150-160 cm: 12 students
- 160-170 cm: 15 students
- 170-180 cm: 5 students
- Work through the method step by step:
- Step 1: Identify the class intervals and frequencies. Write them clearly on the board.
- Step 2: Calculate the class width for each interval. (All are 10 cm in this example.)
- Step 3: Calculate frequency density for each class using the formula Frequency Density = Frequency ÷ Class Width.
- 140-150: 8 ÷ 10 = 0.8
- 150-160: 12 ÷ 10 = 1.2
- 160-170: 15 ÷ 10 = 1.5
- 170-180: 5 ÷ 10 = 0.5
- Step 4: Draw the histogram. Label the x-axis with class intervals and the y-axis with frequency density. Draw bars with heights matching the frequency density values. Bars must touch.
- Step 5: Check the work. Verify that each frequency density calculation is correct. Check that the bars are drawn to the correct heights. Confirm that the axes are labelled correctly.
- As you work through each step, explain your thinking aloud: 'I divide the frequency by the class width because that is the rule for frequency density. This tells us how many data values there are per unit of class width.'
- Show the completed histogram on the board and point out the key features: touching bars, correct labelling, and accurate heights.

GUIDED CLASS PRACTICE WITH CHECKING	• Present a second example for the class to work through together: • Example: A shop recorded the time (in minutes) customers spent shopping. The data is: • 0-10 minutes: 6 customers • 10-20 minutes: 14 customers • 20-30 minutes: 10 customers • 30-40 minutes: 4 customers • Work through the method together, asking learners to contribute at each step: • Ask: 'What is the class width for each interval?' (Answer: 10 minutes) • Ask: 'How do we calculate frequency density?' (Answer: Frequency ÷ Class Width) • Ask learners to calculate frequency density for the first interval aloud: 6 ÷ 10 = 0.6 • Continue with the other intervals, asking different learners to contribute • Draw the axes together on the board. Ask: 'What should we label the x-axis?' and 'What should we label the y-axis?' • Draw the bars together, checking the height of each bar as you go • Ask: 'How can we check that our histogram is correct?' (Answer: Check that each bar height matches the frequency density, check that bars touch, check that axes are labelled correctly) • Correct any errors immediately and explain why the correction is needed
INDEPENDENT TASK AND PEER CHECKING	• Give learners a short independent task: • Example: A school recorded the mass (in kg) of 30 students: • 40-50 kg: 5 students • 50-60 kg: 10 students • 60-70 kg: 10 students • 70-80 kg: 5 students • Learners must: Calculate the frequency density for each class interval, Draw a histogram with correct axes and labels, Check their work by verifying one frequency density calculation and one bar height • Circulate and check learners' working as they complete the task. Ask: 'How did you calculate that frequency density?' and 'How do you know your bar height is correct?' • Pair learners to check each other's work. Ask one learner to explain the method to their partner • Select one learner's work to show on the board (with permission). Ask the class: 'Is this correct? How do you know?'

EVALUATION AND REFLECTION	• Ask learners to respond to evaluation questions (see Evaluation Questions section) • Ask: 'What was the most important step in constructing a histogram?' (Answer: Calculating frequency density correctly) • Ask: 'What is one thing you found tricky today?' Listen to responses and address misconceptions • Remind learners: 'Remember, the rule for histograms is that frequency density = frequency ÷ class width. Always check your working before you finish.' • Preview the next lesson: 'Next time, we will use histograms to answer questions about data and make comparisons between different groups.'
HOMEWORK	• Learners complete a worksheet with 2-3 histogram problems • Each problem should require: Calculating frequency density, Drawing a histogram, Answering one interpretation question (e.g., 'Which class interval has the highest frequency density?') • Learners must show all working and check their answers

TEACHING EXPLANATION

- A histogram is used to display continuous data that has been grouped into class intervals. The key difference from a bar chart is that the bars touch each other, showing that the data is continuous with no gaps.
- Frequency density is calculated using the formula: Frequency Density = Frequency ÷ Class Width. This is necessary because if class intervals have different widths, using frequency alone would give a misleading picture. Frequency density allows fair comparison across all intervals.
- The method for constructing a histogram has five clear steps: (1) Identify the class intervals and their frequencies from the data, (2) Calculate the class width for each interval, (3) Calculate frequency density for each interval using the formula, (4) Draw the histogram with correct axes, labels, and bar heights, (5) Check the work by verifying calculations and bar heights.
- When reading a histogram, the height of each bar represents frequency density, not frequency. To find the actual frequency, you multiply the frequency density by the class width. This is the reverse of the calculation used to construct the histogram.
- Checking is an essential part of working with histograms. Always verify that: each frequency density calculation is correct, each bar height matches the calculated frequency density, the axes are labelled clearly, and the bars touch each other.

DIAGRAMS / GRAPHS

Graph Not Available

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TEXTBOOK-STYLE WORKED NOTES

Example 1: Heights of Students

A teacher measured the heights of 40 students and grouped the data into class intervals of 10 cm. The frequency table shows: 140-150 cm (8 students), 150-160 cm (12 students), 160-170 cm (15 students), 170-180 cm (5 students). To construct a histogram, calculate frequency density for each interval: 140-150: 8÷10=0.8, 150-160: 12÷10=1.2, 160-170: 15÷10=1.5, 170-180: 5÷10=0.5. Draw the histogram with class intervals on the x-axis and frequency density on the y-axis. The bar for 160-170 cm will be the tallest because it has the highest frequency density of 1.5.

Example 2: Time Spent Shopping

A shop recorded the time customers spent shopping. The data shows: 0-10 minutes (6 customers), 10-20 minutes (14 customers), 20-30 minutes (10 customers), 30-40 minutes (4 customers). All class intervals have a width of 10 minutes. Calculate frequency density: 0-10: 6÷10=0.6, 10-20: 14÷10=1.4, 20-30: 10÷10=1.0, 30-40: 4÷10=0.4. The histogram shows that most customers spend between 10 and 20 minutes shopping, as this interval has the highest frequency density of 1.4.

WORKED EXAMPLES

- Worked Example 1 (Teacher-Modelled): Heights of 40 students grouped into 10 cm intervals. Frequency table: 140-150 cm (8), 150-160 cm (12), 160-170 cm (15), 170-180 cm (5). Method: Step 1 - Identify class intervals and frequencies. Step 2 - Calculate class width (10 cm for all). Step 3 - Calculate frequency density using Frequency ÷ Class Width: 0.8, 1.2, 1.5, 0.5. Step 4 - Draw histogram with touching bars and correct labels. Step 5 - Check that each bar height matches the frequency density calculated.
- Worked Example 2 (Guided Class Practice): Time spent shopping by customers. Frequency table: 0-10 minutes (6), 10-20 minutes (14), 20-30 minutes (10), 30-40 minutes (4). Method: Calculate class width (10 minutes). Calculate frequency density: 0.6, 1.4, 1.0, 0.4. Draw histogram with x-axis labelled 'Time (minutes)' and y-axis labelled 'Frequency Density'. Check that bars touch and heights are correct.
- Worked Example 3 (Independent Task): Mass of 30 students. Frequency table: 40-50 kg (5), 50-60 kg (10), 60-70 kg (10), 70-80 kg (5). Method: Calculate class width (10 kg). Calculate frequency density: 0.5, 1.0, 1.0, 0.5. Draw histogram. Check working by verifying one frequency density and one bar height.

BOARD SUMMARY

- HISTOGRAMS: Reading and Interpreting Grouped Data
- Definition: A histogram displays continuous data grouped into class intervals. Bars touch each other.
- Key Rule: Frequency Density = Frequency ÷ Class Width
- Method for Constructing a Histogram:
- Step 1: Identify class intervals and frequencies from the data
- Step 2: Calculate the class width for each interval
- Step 3: Calculate frequency density for each interval using the formula
- Step 4: Draw the histogram with correct axes, labels, and bar heights
- Step 5: Check the work - verify calculations and bar heights
- Example: Heights of students (140-150 cm: 8 students, 150-160 cm: 12 students, 160-170 cm: 15 students, 170-180 cm: 5 students)
- Frequency Density Calculations: 140-150: 8÷10=0.8, 150-160: 12÷10=1.2, 160-170: 15÷10=1.5, 170-180: 5÷10=0.5

- Histogram Features: Touching bars, frequency density on y-axis, class intervals on x-axis, clear labels
- Checking: Verify each frequency density calculation, check each bar height, confirm axes are labelled correctly

TEACHER PROCEDURE

1. Begin with a visual hook: Show a simple histogram and ask learners what they notice. Listen for observations about bars touching and continuous data.
2. State the lesson aim: 'Today we are learning how to read, interpret, and construct histograms. We will learn the method step by step, work through examples together, and check our answers.'
3. Introduce the definition: Explain that a histogram is a graph for continuous data grouped into class intervals, with bars that touch each other.
4. Teach the key vocabulary: Define class interval, class width, frequency, and frequency density. Write the formula Frequency Density = Frequency ÷ Class Width on the board and ask learners to copy it.
5. Explain why frequency density is used: 'If we just used frequency, wider class intervals would always look taller. Frequency density fixes this by showing how many data values there are per unit of class width.'
6. Model the complete method using the first worked example (heights of students). Work through all five steps on the board, explaining your thinking aloud at each step.
7. Ask learners to state the rule before they attempt any practice: 'What is the formula for frequency density?' Correct any misstatements immediately.
8. Guide the class through the second example together. Ask different learners to contribute at each step. Correct errors while learners are still working so the wrong method does not settle.
9. Circulate during independent work. Check each working step, not only the final answer. Ask: 'How did you calculate that?' and 'How do you know your bar height is correct?'

LEARNER ACTIVITIES

- Listen to the introduction and state the lesson aim in their own words
- Copy the definition of histogram and the formula for frequency density into their books
- Observe the teacher-modelled worked example and follow the five-step method
- Contribute to the guided class practice by calculating frequency density, drawing axes, and checking bar heights
- Complete an independent task: Calculate frequency density, draw a histogram, and check the work
- Pair with a partner to check each other's histogram and explain the method used
- Respond to evaluation questions about the method, the rule, and how to check a histogram
- Complete homework: Solve 2-3 histogram problems, showing all working and checking answers

10. Use peer checking: Pair learners to check each other's work. Ask one learner to explain the method to their partner.
11. Select one learner's work to show on the board (with permission). Ask the class: 'Is this correct? How do you know?' This reinforces the checking process.
12. Anticipate and correct common errors: If a learner forgets to divide by class width, stop and explain: 'Remember, we must divide the frequency by the class width. That is the rule for frequency density.'
13. If a learner draws bars that do not touch, explain: 'In a histogram, bars must touch because the data is continuous. There are no gaps between class intervals.'
14. End with evaluation questions. Ask learners to respond individually or in pairs. Listen to responses and address any remaining misconceptions.
15. Assign homework that requires learners to apply the method independently and check their own work.

ACTIVITIES

- Visual hook activity: Show a histogram and a bar chart side by side. Ask learners to identify differences (bars touching, continuous data, frequency density).
- Vocabulary matching: Learners match key terms (histogram, frequency density, class interval, class width) to their definitions.
- Guided calculation activity: Learners calculate frequency density for each interval in the board example, checking their work against the board.
- Histogram construction activity: Learners draw a histogram from a frequency table, following the five-step method on the board.
- Peer checking activity: Learners pair up and check each other's histogram, using a checklist (bars touch, axes labelled, bar heights correct).
- Error correction activity: Show a histogram with an error (e.g., bars do not touch, incorrect frequency density). Learners identify and correct the error.
- Interpretation activity: Learners read a completed histogram and answer questions about frequency, frequency density, and the data.

EVALUATION QUESTIONS

- State the formula for calculating frequency density in a histogram.
- If a class interval has a frequency of 12 and a class width of 5, what is the frequency density?
- Why do the bars in a histogram touch each other, unlike the bars in a bar chart?
- Look at a histogram showing the ages of 50 people. The 20-30 age group has a frequency density of 0.8. How many people are in the 20-30 age group?
- Explain the steps you would follow to construct a histogram from a frequency table.

- A learner drew a histogram with bars that do not touch. What error has been made, and how should it be corrected?
- In a histogram, what does the height of each bar represent?

ASSESSMENT

- Formative check 1: Ask learners to state the formula for frequency density aloud before they attempt any practice. Listen for correct understanding of the rule.
- Formative check 3: During independent work, select one learner's histogram to show on the board. Ask the class: 'Is this correct? How do you know?' This checks understanding of the method and the checking process.
- Formative check 4: Ask learners to explain the method to a partner. Listen for accurate use of vocabulary and correct understanding of each step.
- Summative assessment: Learners complete an independent histogram task. Mark using a checklist: Frequency density calculated correctly for all intervals (yes/no), Histogram drawn with correct axes and labels (yes/no), Bar heights match frequency density calculations (yes/no), Bars touch each other (yes/no), Learner can explain the method (yes/no).
- Homework assessment: Mark the homework worksheet. Check that all frequency density calculations are correct, the histogram is drawn accurately, and the learner has shown checking of their work.

DIFFERENTIATION / SUPPORT

- Support for slower learners: Provide a partially completed frequency table and a template histogram with axes already drawn. Work through the first frequency density calculation together before the learner attempts the others. Check each step before the learner moves to the next. Use a calculator if needed to reduce arithmetic errors. Pair with a stronger learner for peer checking.
- Extension for faster learners: Give a histogram with unequal class widths (e.g., 0-10, 10-20, 20-40). Ask the learner to calculate frequency density and explain why unequal class widths make frequency density even more important. Provide an interpretation question: 'Which class interval has the highest frequency?' (not frequency density). Ask the learner to explain the difference.
- Alternative response modes: Allow learners who struggle with writing to explain the method aloud to a partner or the teacher. Allow learners to use a calculator for frequency density calculations. Allow learners to use graph paper with pre-drawn axes to focus on accuracy of bar heights rather than axis drawing.

HOMEWORK

- Complete a worksheet with 2-3 histogram problems. Each problem should include: A frequency table with grouped data and class intervals, Instructions to calculate frequency density for each interval, Instructions to draw a histogram with correct axes and labels, One interpretation question (e.g., 'Which class interval has the highest frequency density?' or 'How many data values are in the 20-30 interval?')
- Learners must show all working for frequency density calculations. Learners must check their work by verifying one frequency density calculation and one bar height. Learners must write a short explanation of why frequency density is used instead of frequency in histograms.

SUMMARY

The lesson worked through histograms step by step, explained the method, and checked the result carefully.

SUGGESTED TEACHING VISUALS

- drawing of histograms

TEACHER REFLECTION

- Did learners understand the rule for frequency density? If not, which learners need further practice with the formula?
- Were learners able to follow the five-step method in the correct order? Did any learners skip steps or apply steps out of order?
- Did learners check their work as instructed? Which learners need more support with the checking process?
- Which misconceptions appeared during the lesson? (e.g., forgetting to divide by class width, drawing bars that do not touch, confusing frequency with frequency density)
- Were the worked examples clear and detailed enough? Did learners follow the board work easily?
- Did the closely checked class practice activity help learners move towards independence? Were learners ready for the independent task?
- Did the peer checking activity work well? Did learners give each other useful feedback?
- Which learners need additional support before the next lesson? Which learners are ready for extension work?
- Did the lesson stay focused on histograms and the specific method taught? Were there any distractions or drift into unrelated topics?
- What will I do differently next time to improve the clarity of the method or the pace of the lesson?