The New Senior Secondary Curriculum for Sierra Leone

Subject syllabus for Statistics and Probability
Subject Discipline: Mathematics and Numeracy

This subject syllabus is based on the National Curriculum Framework for Senior Secondary Education. It was prepared by national curriculum specialists and subject experts.

SSSC
Senior Secondary School Curriculum

Curriculum elements for Statistics and Probability – a core subject

Subject description

Statistics is the branch of Mathematics that deals with data. It helps us to make sense of the huge amount of information we encounter in everyday life. The process of summarising, analysing, interpreting and presenting information happens in almost all aspects of our lives.

Rationale for the inclusion of Statistics and Probability in the Senior Secondary School Curriculum

a) The world is a data-driven world, and Sierra Leone is no exemption. As has been seen in the Coronavirus pandemic, decisions by health authorities are all data-driven.
b) It is therefore important that statistical literacy be given prominence so that the future generations become confident in understanding the use of data in health education, industry, technology, general and local government and many other organisations that allocate resources and plan services for everyone. Statistical literacy also means that citizens are aware of how statistics can be used to influence and manipulate public opinion.
c) Statistics-related jobs have increased and will continue to increase in a world that will remain data-driven. Statistics in schools will teach pupils the crucial skills they will need to succeed in a data-driven world.
d) In growing economies such as Sierra Leone, businesses will expand. There will be opportunities for new businesses to emerge. Governments will find themselves needing statisticians to analyse data that will help them provide services for their economies and their people.
e) This course will lay the foundation for future statisticians. The practical hands-on approach of the course will begin to equip pupils with the skills needed to approach national issues from a statistical viewpoint.

General learning outcomes and broad goals

By the end of this course, pupils will:

- Have a better, grounded understanding of statistics and be able confidently to have statistical discussions.
- Have gained skills in writing statistical projects, as the prelude to further project report writing at higher institutions or workplace report writing.
- Have the basis in statistics to open a potential career path, as many jobs see understanding how to manipulate data and interpret statistics as a huge asset.

Subject content outline (Themes and topics to be covered)

Definition of data and types of data

- Primary/secondary data
- Categorical/numerical data
- Discrete/continuous data

Collecting data

- Secondary and primary data
- Experiments
- Surveys

Population, census and sampling methods

Questionnaires

Representation of data

- Pictograms, bar charts, pie charts, two-way tables, time series graphs
- Using appropriate methods of tabulation to enable the construct of statistical diagrams
- Interpreting statistical diagrams

Grouping data

- Construct grouped frequency table with equal class intervals
- Identify the modal class interval from grouped frequency table
- Frequency diagram from grouped discrete data
- Histograms from grouped continuous data
- Frequency polygons.

Statistical measures – introduction to averages

- Concept of average for data in form of a list or a frequency table
- Mean, median, mode and range for discrete data set
- The advantages and disadvantages of using mean, median and mode

Use of scaling to calculate the mean

Probability – basics

- Understanding the term 'probability'
- Language of probability
- Probability scale
- Probability of events happening

Statistical measures – working with averages

- Estimating Mean from grouped data
- Identifying modal class for grouped data and the class interval that contains the median

Stem and leaf diagrams

- Back-to-back stem and leaf diagrams

Statistical investigation

- (End-of-Year Mini Project)

Scatter graphs and correlation

- Scatter graphs
- Positive, negative and no [zero] correlation
- Lines of best fit
- Interpolation
- Extrapolation

The equation of a line of best fit

Further representation and interpretation of data (Parts 1, 2, 3)

- Comparative pie-chart
- Interquartile range of discrete dataset
- Box and whisker plots

Outliers

Misleading data, presentations and statements

Histograms

- Histograms of unequal interval

Tabulation and curves

- Cumulative Frequency curve from grouped discrete data
- Estimating median and interquartile range

Deciles and percentiles

Cumulative frequency polygons

Cumulative frequency step polygons

Theoretical and experimental probability

- Theoretical probability
- Experimental probability/relative frequency
- Mutually exclusive events
- Expected frequencies

Probability and independent events

- Independent events and tree diagrams

Conditional probability

Statistical investigation – project work

Index numbers

- Price relative
- Chain base numbers
- Weight index numbers
- Retail price index

Time series and moving averages

Correlation and regression

- Spearman's rank correlation coefficient

Variance and standard deviation

Shapes of distributions

- Symmetrical distribution
- Positive skew
- Negative skew

Geometric mean

Standardised scores

Structure of the syllabus over the three-year Senior Secondary School cycle

	SSS 1	SSS 2	SSS 3
Term 1	**Definition of data and types of data** • Primary/secondary data • Categorical/numerical data • Discrete/continuous data **Collecting data** • Secondary and primary data • Experiments • Surveys **Population, census and sampling methods** **Questionnaires** **Representation of data** • Pictogram, bar charts, pie charts, two-way tables, time series graphs • Using appropriate methods of tabulation to enable the construct of statistical diagrams • Interpreting statistical diagrams	**Scatter graphs and correlation** • Scatter graphs • Positive, negative and no [zero] correlation • Lines of best fit • Interpolation • Extrapolation **The equation of a line of best fit** **Further representation and interpretation of data (1, 2, 3)** • Comparative pie-chart • Interquartile range of discrete dataset • Box and whisker plots **Outliers** **Misleading data, presentations and statements**	**Index numbers** • Price relative • Chain base numbers • Weight index numbers • Retail Price Index **Time series and moving averages** **Correlation and regression** • Spearman's rank correlation coefficient **Variance and standard deviation**
Term 2	**Grouping data** • Construct grouped frequency table with equal class intervals • Identify the modal class interval from grouped frequency table • Frequency diagram from grouped discrete data • Histograms from grouped continuous data • Frequency polygons.	**Histograms** • Histograms of unequal interval **Tabulation and curves** • Cumulative frequency curve from grouped discrete data • Estimating median and interquartile range **Deciles and percentiles** **Cumulative frequency polygons** **Cumulative frequency step polygons**	**Shapes of distributions** • Symmetrical distribution • Positive skew • Negative skew **Geometric mean** **Standardised scores**

	Statistical measures – introduction to averages • Concept of average for data in form of a list or a frequency table • Mean, median, mode and range for discrete data set • Know the advantages and disadvantages of using mean, median and mode **Use of scaling to calculate the mean** **Probability - basics** • Understanding the term 'probability' • Language of probability • Probability scale • Probability of events happening		
Term 3	**Statistical measures – working with averages** • Estimating mean from grouped data • Identifying modal class for grouped data and the class interval that contains the median **Stem and leaf diagrams** • Back-to-back stem and leaf diagrams **Statistical investigation** • (End-of-Year Mini Project – 4-6 weeks)	**Theoretical and experimental probability** • Theoretical probability • Experimental probability/relative frequency • Mutually exclusive events • Expected frequencies **Probability and independent events** • Independent events and tree diagrams **Conditional probability** **Statistical investigation – project work**	**(Review and revision)**

Senior Secondary Level 1

Topic/Theme/Unit	Expected learning outcomes	Recommended teaching methods	Suggested resources	Assessment of learning outcomes
Definition of data and types of data • Primary / secondary data • Categorical / numerical data • Discrete / continuous data	By the end of this topic, pupils will be able to: • Define data in their own words • Distinguish between Primary and Secondary data • Distinguish between categorical data and numerical data • Pupils should know that numerical data can be discrete or continuous and understand the usage of these words	• Open question to the class: 'What is data?' • Record pupils' responses on the board with probing questions to clarify misconceptions and collectively answer question 'What is data?' • Teacher modelling for primary/secondary data, categorical/numerical data, and discrete/continuous data • Display keywords around classroom (and corridor)	• Display of different types of data • Measuring instruments: ruler, tape measures, • cards/vanguard • Lesson Plan Manual	• Pupils are asked to group given data into categorical or numerical and discrete or continuous using matching cards • Pupils to work in pairs or in groups to look around the classroom or local environment and produce: • 5 real-life examples each of categorical and numerical data. • 5 real-life examples each of measurements that will produce discrete and continuous data
Collecting data • Secondary and primary data • Experiments • Surveys	• By the end of this topic, pupils will be able to: • State what sort of data to collect and the appropriate and efficient method to obtain it	*Teacher modelling* • Primary and secondary data and their main advantages and disadvantages. • The main survey methods: • Observation – involves monitoring behaviour or information; Personal interviews;	• Internet • Lesson Plan Manual • Statistics Sierra Leone • website	• Pupils to answer standard questions on Data and Data Collection. *Probing Questions* • Adama wants to carry out an

	• List advantages and disadvantages of secondary and primary data • Describe the advantages and disadvantages of the main survey methods • Design an experiment to collect data and identify the independent and dependent variables • Describe the main survey methods and their advantages and disadvantages.	Telephone surveys; Postal surveys; Online surveys • Discuss the advantages and disadvantages of survey methods. • Discuss designing an experiment to collect data and clearly define the Independent and dependent variables • Control group when testing the effect of different factors in an experiment. • Before-and-after experiment to help see the difference an intervention can produce, e.g., a pre-assessment given before a training programme and after the training a post-assessment is done. • Capture and recapture method of estimating the size of a self-contained population.		experiment on which age group in her school is best at estimating the length of a Line • What would be the independent and dependent variables for her experiment? • What was important in the way you chose to collect your data? • How do you know you have collected enough data? • What options have you got in organizing your data? • Fifty fishes were caught and returned to a particular aquatic habitat. In a second sample of thirty fishes, five are found to have tags. Using the capture and recapture method, estimate the number of fishes in the habitat. • What factors will you consider when

				capturing and recapturing the fishes?
Population, census and sampling methods	By the end of this topic, pupils will be able to: • Explain the terms 'population,' 'census' and 'sample' • State that population is everything or everybody involved in the study Explain that census data collects information from every member of the population and that sample data collects information from part of the population • Describe the advantages and disadvantages of using census data, against taking a sample from the population • Explain what 'bias' is and how to avoid bias in a sample • Use various sampling methods	*Teacher modelling and open discussions* • What is 'population,' what is a census and what is a sample? What is an appropriate sample size? • Together with pupils, outline the advantages and disadvantages of census and sample. Example: Census includes every member of the population but can be expensive. Sample can be cheaper but may not be reflective of the entire population. • Through open discussions and probing questions, explain what 'bias' means in Statistics. Get pupils to compile a list of possible sources of bias. • Model sampling methods and their limitations: simple random sampling; stratified sampling; systematic sampling; opinion polls/perception surveys	• Lesson Plan Manual • Statistics Sierra Leone website • Internet	• Pupils answer standard questions. *Probing questions* • Andriana wanted to investigate the statement 'children no longer do enough sports.' She surveyed all the children in her school. • Explain why the sample may be biased. • Explain a better method she could use to choose the sample. • Design a questionnaire she can use to carry out the investigation. • Are there different ways you could have asked your questions? Explain.
Questionnaires	By the end of this topic, pupils will be able to:	*Teacher modelling and open discussion with pupils:* • What is a questionnaire?	• Lesson Plan Manual • Internet	• Comment critically on the following questions. How

	• Name the key elements of a questionnaire • Describe how to conduct and use pilot surveys	• How do you structure a questionnaire? • Types of questions • Response boxes • Overlapping responses • Teacher modelling • What is a pilot survey? • Why is it important and how can the result be used in the actual survey? • Pupils choose two areas they would like to investigate and design questionnaires to collect the information.		could they be improved? • Do you watch a lot of television? • Do you agree that teachers at your school are excellent? • How much time do you spend on doing your Mathematics homework?
Representation of data • Pictogram, bar charts, pie charts, two-way tables, time series graphs • Using appropriate methods of tabulation to enable the construct of statistical diagrams • Interpreting statistical diagrams	By the end of this topic, pupils will be able to: • Recognise, construct and interpret pictograms, bar charts (vertical, horizontal and composite) and pie chart. • Use ICT (spreadsheet) to design charts. • Complete and answer questions from two-way tables. • Draw a time series graph and describe changes over a period of time.	• Display various charts as seen in real life situations E.g., newspapers (Awoko Business section, https://awokonewspaper.sl/category/business-finance/, adverts, magazines, websites. • Get pupils to identify charts and discuss amongst themselves before asking them to share with the whole class their understanding of the charts and what information they can draw.	• Newspapers, reports, advertisement, magazines • Compasses and rulers • Secondary data	• Pupils are given secondary data and asked to construct appropriate charts. *Probing questions* • How did you decide on how to organize your table of results? • Explain how you went about collecting the data? • What made your chart easy or difficult to construct? • Which chart(s) is mainly used to represent categorical data?

Grouping Data • Construct grouped frequency table with equal class intervals • Identify the modal class interval from grouped frequency table • Frequency diagram from grouped discrete data • Histograms from grouped continuous data • Frequency polygons.	By the end of this topic, pupils will be able to: • Construct grouped frequency table with equal class intervals and identify the modal class interval from grouped frequency table. • Construct and interpret frequency diagram from group discrete data. • Construct and interpret Histograms from grouped continuous data • Construct frequency polygons and compare two or more sets of data using super imposed frequency polygons.	• Display the various charts as seen from real life examples from newspapers, adverts, textbooks and magazines. • Pupils given opportunities to talk about charts • /diagrams/graphs and their understanding of the charts. • Model the construction of each chart. • Ensure pupils understand scaling of axis. • Pupils construct their own diagrams. • Pupils work put on display.	• Graph paper • Plain paper • Newspapers • Magazines • Coloured pencils	• Pupils answer standard questions on constructing tables and drawing frequency diagrams, Histograms, Frequency Polygons. *Probing questions* • What difference(s) can you see between a frequency diagram and a histogram? • If you were to collect data to draw a histogram, what type of data would you collect? Give examples of such data. • What is important when choosing the scale of your graphs.
Statistical measures – introduction to averages • Concept of average for data in form of	By the end of this topic, pupils will be able to: • Calculate mean, median, mode and range for discrete data set.	*Pre-lesson activity:* • Select seven volunteers to come to the front of the class. • Get the pupils to arrange themselves in ascending order of their heights (from left to right facing the class) • Explain to class that the pupil in the middle is said to have the median height. The pupil on		• Standard questions on mean, median, and mode. *Problem solving* • Find a set of five positive whole numbers with: - Range 10

a list or a frequency table • Mean, median, mode and range for discrete data set • The advantages and disadvantages of using mean, median and mode	• Examine data and identify extreme values [outliers]. • State the respective advantages and disadvantages of using mean, median and mode.	the far left has the lowest height and the pupil on the far right has the highest height. • Explain that heights range from the shortest to the tallest and the range can be calculated by subtracting the smallest height from the largest height. • Repeat this exercise for an even number of pupils e.g., 10 pupils. • Ask pupils if they notice anything different about the median. Accept different responses • (e.g., there are 2 pupils; It is between the 2 pupils). • Discuss with pupils the best way of resolving the median height, i.e., adding the 2 middle heights and dividing by 2. • Get pupils into small groups. Give each group sets of numbers to arrange in order of size. Some sets of numbers should contain extremely high and low values. • Pupils to discuss in their groups and talk about possible outliers and the median. • Model with whole group: calculation of mean, median, mode and range. • Pupils answer standard question on mean, median, mode and range. • Summarise advantages and disadvantages of mean, median and mode.		- Mode 4 - Median 6 - Mean 7 • Is there more than one possible set? • Repeat for a set of six numbers. Find as many possible answers as you can *Probing questions* • Is the median the most appropriate average to calculate for this data set? Convince me. • Convince me that the mean is the most appropriate average to calculate for this data set. • Convince me that the mode is the most appropriate average to calculate for this data set.
Use of scaling to calculate the mean	By the end of this topic, pupils will be able to: • Work with large numbers by scaling.	*Teacher modelling* • Example, find the mean of 5,018, 5,006, 5,007, 5,020, 5,009, 5,012, 5,017. • Using scaling method, subtract 500 from each value to give 18, 16, 7, 20, 9, 12, 17.	• Lesson Plan Manual	• Pupils to answer standard questions on scaling. *Probing questions* • Could you do scaling by dividing?

		• The mean of these given 12.71. Then add 5,000 to give a final mean of 5,012.71		Try a few examples of your own. • Could you do multiple operations by dividing and then subtracting? Try a few examples of your own.
Probability - basics • Understanding the term 'probability' • Language of probability • Probability scale • Probability of events happening	By the end of this topic, pupils will be able to: • Accurately use simple language of probability Certain, impossible, likely, unlikely, even chance, impossible, outcomes, equally likely • Use and interpret a probability scale. • Calculate probability of events happening. • Draw a sample space diagram for given events. • Determine the probability of an event occurring from a sample space diagram.	• Open discussion: What is probability? Is it a concept we use in everyday life? • Give me examples. • Teacher modelling of: Tossing a coin and probability of tails; tossing a coin and probabilities of heads; probability of getting a '1' or '2' or '3' or '4' or '5' or '6' when a die is cast. • A sample space of all outcomes when two coins are spun together. • Standard questions on probability including probability scale.	• Coins • Dice • Counters	• Give me three situations where probability is used in everyday life. • Write down or explain two situations where you used probability to make a decision in real-life situation this week. • Can you give me an example of what is meant by 'equally likely outcomes'? • The probability of getting a '3' when a die is thrown is 1/6. Can you explain why? • When a coin is tossed, the probability of getting tails is ½. Can you explain why?

				• Give me examples of probabilities for events that could be described using the following words: Impossible' Certain, Unlikely, Even chance • Show these on a probability scale

Statistical measures – working with averages • Estimating mean from grouped data • Identifying modal class for grouped data and the class interval that contains the median	By the end of this topic, pupils will be able to: • Calculate an estimate of the Mean from grouped data. • Identify the modal class interval and the class interval where in the median of the data lies.	• Review prior knowledge from SSS1 on mean, median, mode and range from a list. • Also review mean from frequency table . • Review – tallying of data for frequency table. • Use of the inequality sign when grouping data. • Teacher models how to estimate mean for grouped data and show how this is almost similar to calculating mean from a frequency table. • The concept of 'mid-point' should be carefully modelled and 'teased-out' from pupils by questioning and finally concluding that the mid-point is merely representing all the numbers within a class interval. Hence the mean becomes only an estimate. Explain to pupils that by grouping the data, we have lost the frequency of the individual members of the class-interval and remain with only the total frequency of the class interval. • Teacher models how to identify the modal class interval and the interval where the median lies.	Lesson Plan Manual	• Pupils answer standard questions. *Probing Questions* • Why is it only possible to estimate the Mean from grouped data? • Why is the mid-point of the class interval used to calculate an estimated mean? • Why not the end of the class interval? • Write an essay on the steps you will take to estimate the mean from grouped data. • How could you possibly use a grouped frequency table to estimate the range and the median?
Stem and leaf diagrams • Stem and leaf diagrams • Back-to-back stem and leaf diagrams	By the end of this topic, pupils will be able to: • Draw a stem and leaf diagram and use it to find mode, median and range. • Construct and use a back-to-back stem and Leaf diagram to	• Before modelling the construction of a stem and leaf diagram, get pupils into groups and give each group a completed stem and leaf diagram and the raw data from which it was constructed. Get pupils to study both materials and come to a conclusion as to how the data was transformed into a diagram. • Encourage pupils to explain to the rest of the class.	• Completed stem and leaf diagram and its raw data. • Completed back-to-back stem and leaf diagram and its raw data.	• Pupils answer standard questions • Examine your stem and leaf diagram. What does the shape tell you about the data? • Examine the shape of your back-to-back

	compare two distributions.	• Finally, model the construction of a stem and leaf diagram, a back-to-back stem and leaf diagram. • Teacher models how to find the range and median from stem and leaf diagram and to compare distribution.		stem and leaf diagram. Write as many differences and similarities as you can see between the two data sets.
Statistical Investigation • (End-of-Year mini project: 4-6 weeks)	By the end of this topic, pupils will be able to: • Investigate a problem of their choice by specifying the problem and planning by collecting the relevant data; by processing and representing the data; by interpreting, discussing, comparing and making predictions.	• Teacher modelling and suggestions on problems to be investigated, e.g., Girls do better at Maths than boys; More men die of Corona Virus than women; More women wear facemasks than men; On average, boys are taller than girls; Prices of goods at one market are higher than prices of the same goods at another market.	• Different sources of secondary data • Internet • Graph paper • Measuring instruments • Lined paper • Plain paper • Coloured pencils / crayons	• Well-written plan with an overall strategy. The aims are identified with a clear hypothesis. • Appropriate data is collected. The type of data is described, and the sampling method clearly explained. • When processing and representing data, comparisons are made, tables and graphs are drawn and there is some organisation of the data. Probability calculations may be included • The interpretation and discussion of findings relate the results, tables and

				graphs to the original Hypothesis *Probing questions* • What was important in the way you chose to collect your data? • What options do you have in organising your data? • What other questions could you ask of the data? • Do you think you can make sub-categories within your data? • Explain.

Senior Secondary Level 2

Topic/Theme/Unit	Expected learning outcomes	Recommended teaching methods	Suggested resources	Assessment of learning outcomes
Scatter graphs and Correlation • Scatter graphs • Positive, negative and no [zero] correlation • Lines of best fit • Interpolation • Extrapolation	By the end of this topic, pupils will be able to: • Explain and illustrate with examples scatter graphs as a graph used to see if there is a relationship between two variables. • Draw scatter graphs and describe the relationship between two quantities using the terms 'positive correlation,' 'negative correlation and 'no correlation.' • Draw and use line of best fit, and state if two variables have strong positive/negative correlation. • Use their line of best fit to make predictions by Interpolation or extrapolation and know that predictions from extrapolation may not be accurate.	*Review and teacher modelling* • Plotting co-ordinates in the first quadrant to include: x-axis, y-axis, scaling of axes and actual plotting of co-ordinates from given linear function. • Drawing scatter graph from any 2 variables, e.g., height of pupils plotted against their handspan; test scores in Mathematics plotted against test scores in Science. • Description of relationship using appropriate language, e.g., positive correlation, negative correlation, no correlation, weak positive correlation. • Drawing of line of best fit and how it can be used to find one variable, given the other variable, e.g., in a scatter graph of mathematics scores plotted against science scores, if one score is missing for a particular pupil the other score could be predicted using the line of best fit. • Teacher explains the difference between Interpolation (predicting data values within the range of	• Graph paper • Secondary data • Lesson Plan Manual	• Pupils answer standard questions on scatter graph. *Probing Questions* • What sort of correlation would you expect to find between: - Height and handspan - Height and test - Marks scored in Mathematics - Price of car and the age of the car - Pupil's shoe size and geography exam score. - Distance a motorist travels and amount of fuel used - The speed of a car and the time taken to get to its destination • Could you see a potential problem if you choose to collect data

		the data given) and Extrapolation (predicting data values outside the range of the data given)		from your friends? Explain • How would you spot outliers from your scatter graph?
The equation of a line of best fit	By the end of this topic, pupils will be able to: • Find a formula connecting 2 variables used in their scatter graph, in the form y=mx+c	*Teacher modelling* • Prior knowledge: • Finding gradient of a straight line • Draw line of best fit passing through the Mean average of each data set • Extend the line of best fit so that it intersects with the y axis. This is the value of c • Then calculate the gradient of the line of best. This is the value of m • Substitute both values for c and m respectively into the equation y – mx + c. Then replace 'y' with the variable plotted on the y-axis, and 'x' with the variable plotted on the x-axis. Letters can be used to represent these variables	• Graph paper • Lesson Plan Manual • Online resources	• Standard questions on gradient and Lines of Best Fit. *Practical activity* • Pupil collects primary data and draws scatter graph, then line of best fit followed by equation of line of best fit *Probing Questions* • Explain why the line of best fit was drawn through the point of the mean average of the two data sets
Further representation and interpretation of data - 1 • Comparative pie-chart	By the end of this topic, pupils will be able to: • Explain and demonstrate that when using pie-charts to compare two or more datasets, the areas of the circles must be in the proportion of the totals.	• Teacher explains that when using pie charts to compare two data sets, the areas of the circles must be in the proportion of the totals so that it does not appear as misleading diagrams *Teacher modelling, e.g.:* • In 2020 a bike store sold 1,000 bikes of different models. In 2021	• Compasses, pencil, ruler, calculators	• Pupils answer standard questions on comparative Pie Charts. *Probing Questions* • A company rented out 1,000 chairs of different colours in the month of June. In July, the number of chairs of

		the number of bikes sold increased by 20%. • If you choose a radius of 5cm for the 2020 pie chart, what radius should you use for the 2021 pie chart?		different colours rented out increased by 30%. • Two pie charts of the same radius were drawn to represent this information. • Explain how this is misleading.
Further representation and interpretation of data - 2 • Interquartile range of discrete dataset	By the end of this topic, pupils will be able to: • Find the interquartile range of discrete data using upper and lower quartiles and why it is a better measure of spread than the range.	• Teacher modelling • Recap the median as the number in the middle of a set of data after it has been arranged in ascending order and that if the middle falls in the space between two numbers, then the median is the mean of these two numbers. • Explain that the median divides the data into two equal halves and that the median is never smaller than the numbers on the left-hand side and never bigger than the numbers on the right-hand side. • Explain that quartiles divide the data into four equal parts. The number in the middle of the left-hand side is called the lower quartile and the numbers in the middle of the right-hand side is called the Upper quartile. • (The same rule applies if the middle falls between two numbers)	• Standard questions on Interquartile range.	• Pupils answer standard questions on Interquartile range. *Probing questions* • How would you go about making up a data set with a median of 10 and an Interquartile range of 7? • Explain why the Interquartile range cannot be greater than the range. • Explain how you would find the Interquartile range from a stem and leaf diagram. • Why is it easier to find the median and Interquartile range from a stem and leaf diagram? • Write down one advantage of using the

		• The interquartile range is the difference between the upper quartile and the lower quartile. This process should be modeled with examples from the board. • Pupils answer standard questions on calculating interquartile range from discrete data. • Open discussion on calculating interquartile range - e.g., what part of data would you apply it to? How would you use the interquartile range to compare two sets of data.		Interquartile range instead of the range. • Give one disadvantage of using the Interquartile range. • When would you expect to find one number as a median in the middle of the ordered data set? (Hint: think about the number of members in the set)
Further representation and interpretation of data - 3 • Box and whisker plots	By the end of this topic, pupils will be able to: • Draw a box and whisker plot and use it to compare two or more data sets	• Box and whisker plot: A diagrammatic representation of interquartile range. • Modelling of box plot on graph paper to include the - Median - Lower quartile - Upper quartile - Lowest data value - (vertical line on the right of the median). - Highest data value *Alternatively* • Present a completed box and whisker plot to pupils with no labels on them other than the number line at the bottom. • Tell pupils that this diagram is a box and whisker plot and the	• Graph paper	• Pupils answer standard questions on box plot. *Probing Questions* • You are given two box plots for two different data sets. How can you tell at a glance which box plot shows the largest Interquartile range?

		vertical lines on it represent the median, the lower quartile, upper quartile – highest data value and lowest data value. • Pupils' task is to work out where to place these measures on the box plot. • Once completed, clarify errors and misunderstanding by modelling how to draw a box and whisker plot.		
Outliers	By the end of this topic, pupils will be able to: • Explain and illustrate that any value in a data set that is unusual in comparison with the rest of the data is an outlier. • Be able to calculate and identify outliers	*Teacher modelling* • Explain that to find outliers you find value 1.5 times the interquartile range below the lower quartile and the value 1.5 times above the upper quartile. • Any values outside this range are outliers.	• Lesson Plan Manual	• Standard questions *Probing questions* • Suggest reasons why there could be outliers in a dataset.
Misleading data, presentations and statements	By the end of this topic, pupils will be able to: • Explain that statistical diagrams can be used to present evidence to suit the point that someone wants to make. • Interrogate a statistically claim and decide whether or not it is misleading	*Teacher modelling* • Bar charts not showing the origin on the frequency scale. • Bar charts with bar of different widths. • The vertical axis has an uneven scale or no scale at all. • Instead of using Length to represent frequency area or volume is used to mislead. • Diagrams drawn in 3-D gives distorted image of size.	• Internet	• Pupils answer standard questions on 'misleading information. *Probing questions* • The data given is the salaries of staff working in a factory. • The factory wants to put out an advert to attract new staff. Which of the averages will be the most appropriate?

		• Situations where the median will best describe the data. The mean is used to produce an inflated value. • Pie charts of the same radius used to compare data of different sizes. • Parts of graphs omitted to give a false impression. • Graphs drawn using thick lines or shadows make them difficult to read.		• Give reasons for your answer. • Critically analyse the statement: • 'Sales increased by Le20,000.000.00 over the last year' • Would you say business was good last year? Explain. • Search the internet for misleading charts.
Histograms • Histograms of unequal interval	By the end of this topic, pupils will be able to: • Draw Histograms of unequal intervals by calculating frequency density. • Frequency density = frequency ÷ class width	*Teacher modelling* • Explain to pupils that a histogram with equal intervals is the same as a frequency diagram and the heights represent these frequencies, • Explain to pupils that in a histogram of unequal intervals the area of each bar is proportional to the frequency of each class. • The height of each bar is called the frequency density.	• Graph paper • Lesson Plan Manual • Completed histogram and their tables.	• Pupils answer standard questions *Probing Questions* • Pupils given partly completed Histograms and partly filled tables. • Pupils to use information from one to fully complete the other. • Matching histogram with their tables by inspection.
Tabulation and curves • Cumulative frequency curve from grouped discrete data • Estimating median and	By the end of this topic, pupils will be able to: • Complete a cumulative frequency table and draw a cumulative frequency curve. • Use the cumulative frequency curve to estimate median, quartiles,	*Teacher modelling* • Completion of cumulative frequency table and drawing of cumulative frequency curve.	• Graph papers • Lesson Plan Manual	• Pupils to answer standard questions on cumulative frequency. • Pupils given sets of box and whisker diagrams and cumulative frequency curves, both drawn from the same data. Pupils to match

interquartile range	Interquartile range and semi-interquartile range.			the boxplots with their respective cumulative frequency graphs. *Probing questions* • Which features are you looking for when matching box plots to their cumulative frequency curves?
Deciles and percentiles	By the end of this topic, pupils will be able to: • Estimate deciles and percentiles from cumulative frequency graphs.	*Teacher modelling* • Model estimate • How to estimate deciles and percentiles from completed Cumulative Frequency Diagrams	• Completed cumulative frequency diagrams • Lesson Plan Manual	• Pupils answer standard questions on deciles and percentiles
Cumulative frequency polygons	By the end of this topic, pupils will be able to: • Demonstrate that cumulative frequency shows how that data grows • Distinguish between cumulative frequency curve and cumulative frequency polygon. • Draw cumulative frequency polygons	*Teacher modelling* • Reorganise data from grouped frequency table to a cumulative frequency table. • Plot the cumulative frequency against the upper boundary of each class and join the points with straight diagonal lines.	• Graph paper • Lesson Plan Manual	• Standard questions on cumulative frequency polygons.
Cumulative frequency step polygons	By the end of this topic, Pupils will be able to: • Draw cumulative frequency step polygon for discrete data.	*Teacher modelling* • Cumulative frequency polygon for discrete data and distinguish between cumulative frequency curve for continuous data	• Graph paper • Lesson Plan Manual	• Standard questions on cumulative frequency step polygons.

Theoretical and experimental probability • Theoretical probability • Experimental probability/relative frequency • Mutually exclusive events • Expected frequencies	By the end of this topic, pupils will be able to: • State the difference between theoretical probability and experimental/frequency • Explain the term 'mutually exclusive' • Find the probability of mutually exclusive events • Use the fact that the sum of all mutually exclusive outcomes of an event is 1 • Use the addition rule of probability for mutually exclusive events • Calculate expected frequency	*Teacher modelling* • Theoretical probability is calculated without doing an experiment, e.g., tossing a fair coin. The probability of tails is ½ or 0.5 or 50%. • Probability of getting a six when a die is cast is 1/6. • Experimental probability is probability obtained by actually conducting an experiment and involves a repetition of a large number of trials.	• Dice • Matchboxes • Coins	• Pupils answer standard questions with confidence. *Probing Questions* • A match box is to be used as a die. The two largest faces are each marked with 1 and with 6. The next two largest faces are marked with 2 and with 5 and the two smallest faces are each marked with 3 and with 4. • What two faces will have the largest probability of facing up when the matchbox is thrown as a die? Explain why. • Explain how you would estimate the Probability of obtaining a '3' when the matchbox is cast as a die. • Design and experiment you will carry out to estimate the probability that the first car that goes past the school gate after 8.00am is a green car.

Probability and independent events • Independent events and tree diagrams	By the end of this topic, pupils will be able to: • Calculate probabilities of repeated events. • Draw and use probability tree diagram • Define the term 'independent events' • Use of the multiplication rule for probability • P(A and B) = P(A) x P(B)	*Teacher modelling* • Explain to pupils that independent events are events in which the probability of one occurring does not affect the probability of the other occurring. • Example: getting heads, when a coin is flipped and obtaining an even number when a die is rolled. • Model the construction of a tree diagram for: - A box has 4 blue and 6 black and yellow counters. - A counter is picked at random, the colour noted and then replaced. This is done a second time. • List all possible 4 outcomes (i.e., blue and blue, blue and yellow, yellow and blue, yellow and yellow) and explain to pupils that use of a tree diagram will make them avoid missing any combination. • Model the multiplication rule for probability of independent events and apply to standard questions on probability. • Emphasise the language of probability when answering questions, e.g., 'both,' 'either,' 'neither,' 'with replacement,'	• Lesson Plan Manual • Counters	• Pupils answer standard questions on Probability tree diagrams. *Probing Questions* • In a city, 80 people with Coronavirus symptoms were tested for the virus using a new trial kit • 19 people tested positive. The virus only developed in 11 people who tested positive. A total of 67 people did not develop the virus at all • Using a tree diagram, what is the probability that a person will develop the virus? • Give me an example of a problem which could be solved by adding probabilities, and an example of a problem which could be solved by multiplying probabilities. • What are the key features of mutually exclusive and independent events on the tree diagram?

		'without replacement,' 'at least,' 'at most' • Incorporate the addition rule for probability when modelling solutions on probability.		• Why do the probabilities on each set of branches have to sum up to 1? • How can you tell from a completed tree diagram whether the question specified 'with' or 'without' replacement? • What strategies do you use to check that Probabilities on your tree diagram are correct? • Explain to me the steps you took to draw this tree diagram and how to use it to find the probability of this event.
Conditional probability	By the end of this topic, Pupils will be able to: • Decide if two events are independent. • Draw and use tree diagrams to calculate conditional probability	*Teacher modelling* • Explain conditional probability as the probability of a dependent event. The probability of the second outcome depends on what has already happened in the first outcome. • Model tree diagrams from standard questions and answer standard questions.	• Lesson Plan Manual	• Pupils answer standard questions on conditional probability.
Statistical investigation – project work • End of SS2 Project	By the end of this topic, pupils will be able to: • Investigate a statistical problem of their choice	• Support pupils to structure their written work.	• Paper • Secondary data • Internet • ICT facilities	• Pupils to be able to investigate a problem of their choice by: • Specifying the problem and planning. This may

				be broken down into sub-questions. A hypothesis could also be clearly stated. • Relevant data to be collected from secondary source or primary data collected. A mixture of both primary and secondary data used. • Processing and representing data employ a wide variety of statistical diagrams and charts. • Evidence of good communication skills when interpreting and discussing findings.

Senior Secondary Level 3

Topic/Theme/Unit	Expected learning outcomes	Recommended teaching methods	Suggested resources	Assessment of learning outcomes
Index numbers • Price relative • Chain base numbers • Weight index numbers • Retail Price Index	By the end of this topic, pupils will be able to: • Calculate index numbers e.g., Price relative • Use the formula Index number = quantity x 100 quantity In base year	*Teacher modelling* • Explain to pupils that index numbers are used to compare the rate of charge in prices, quantities, value of items over a period of time. Model price relative as an example of index numbers Price relative = Price x 100 Price in base year • Model chain base numbers, weighted Index numbers and retail price index	• Lesson Plan Manual *Practical activity:* • Pupils to be encouraged to use real life examples of price changes over a period of time. • Price list can be compiled from leading supermarkets	• Pupils answer standard questions on index numbers. • Applying to real life situations. • Comparing various index numbers from local supermarkets/shops/village store.
Time series and moving averages	By the end of this topic, pupils will be able to: • State how to plot and draw a time series graph from data that shows variations on a quarterly, daily, monthly, weekly etc, • Describe, with examples, that time series are often found in	*Teacher modelling* • Recall prior knowledge on drawing line graphs. • Model how to plot and draw a time series on graph paper from secondary data. • From time series highlight the fact that Variation in sales or figures can be seen by	• Lesson Plan Manual • Secondary data on seasonal, or monthly, weekly, or daily etc sales figures of businesses over a period of time • Graph paper	• Pupils to answer standard questions on time series and moving averages. *Probing questions* • Examine the table showing daily sales in a shop, over a 4-week period • How can you describe the trend and daily variations?

	businesses, and they pose a problem in terms of making business predictions • Calculate moving averages from sales figures and plot these to produce trend line or a line of best fit that can be used to make predictions.	rise and fall of the time series. • Explain that to smooth out the 'peaks' and 'troughs' a moving average can be calculated and plotted on the time series. • To calculate a moving average, e.g., for quarterly figures, a 4-point moving average is calculated. First calculate the mean for the first 4 quarters. Then omit the first quarter and include the fifth quarter and find the new mean. Then omit the second quarter and include the sixth quarter and find the new mean, and so on. • These moving averages are each plotted at the middle of their respective interval. • Then draw a trend line through these moving averages. This trend line can then be used		• For quarterly figures, a 4-point moving average was calculated. • Why? • If you have daily figures, how many points moving average will you calculate? • What about monthly figures in a year?

		to make reasonable predictions by reading off from the graph		
Correlation and regression • Spearman's rank correlation • coefficient	By the end of this topic, pupils will be able to: • Show, with workings, that Spearman's rank correlation co-efficient (r_s), is a measure of the extent to which two sets of data are in agreement • Show that the closer r_s is to +1 the more agreement there is (positive correlations) • Show that the closer rs is to -1, the more disagreement there is (negative correlation) and that the closer r_s is to zero, the more there is neither agreement nor disagreement	*Teacher modelling* • Rank each data value in its data set and find the difference [d] between corresponding ranks. • Use of formula $r_s = 1 - \frac{6\sum d^2}{n(n^2-1)}$ where n is the number of pairs of data.	• Lesson Plan Manual	• Standard questions on Spearman's rank correlation coefficient *Probing questions (Example)* • Which of the numbers – 0.73, 0.29, 0.87 indicates the least correlation? Explain how you arrived at your answer.
Variance and standard deviation	By the end of this topic, pupils will be able to: • Demonstrate with examples that variance is a measure of spread that uses all the data, unlike the interquartile range that uses two values, the upper and lower quartile	*Teacher modelling* • Model use of formulae to calculate variance and standard deviation.	• Lesson Plan Manual • Formulae	• Standard questions on variance and standard deviation.

	• State that the square root of the variance is called standard deviation • Calculate variance and standard deviation by use of formulae, including standard deviation formulae for frequency distributions and grouped frequency distribution			*Probing Questions* • You are given several data sets. Some with outliers and some without outliers. If you are to measure spread, explain which ones you will apply the Interquartile range to and which ones you will apply the variance to.
Shapes of distributions • Symmetrical distribution • Positive skew • Negative skew	By the end of this topic, pupils will be able to: • Recognise symmetry, positive skewness and negative skewness in a distribution	*Teacher modelling* • Get pupils to join together the midpoint of the bars in a frequency diagram or a histogram. • A general shape would be seen: a symmetrical shape with most data in the middle is called symmetrical distribution. • The symmetrical distribution is also called 'normal distribution' e.g., heights of randomly selected people. Positive skew is when most data are at the lower values. Negative	• Lesson Plan Manual • Previously drawn frequency diagrams • Internet	• Pupils to answer standard questions on recognising distribution from given data/frequency diagram. *Probing questions* • How would you go about matching the shape of a distribution to the shape of its box and whisker plot and its cumulative frequency curve?

		skew is when most data are at the higher values.		
Geometric mean	By the end of this topic, pupils will be able to: • Explain and show by example the difference between a geometric mean and an arithmetic mean	*Teacher Modelling (Example)* • Geometric Mean of 4 and 9 $= \sqrt{4 \times 9} = 6$ • Geometric mean of mean of 6, 7 and 8 is the cube root of the product of 6, 7 and 8. • It is the nth root of the products of the n items in a distribution	• Lesson Plan Manual	• Standard questions on geometric mean. • Calculate both the geometric mean and arithmetic mean of 3, 8, 10, 12. • What do you notice? • One year the interest paid in a bank account is 4%. The following year the interest paid is 9%. Using the geometric mean, show that the equivalent single rate is 6.47% [3.s.f]
Standardised scores	By the end of this topic, pupils will be able to: • Calculate standard scores and its use in comparing values from different data sets	*Teacher Modelling* • Recap calculation of Mean and standard deviation. • Standardised score [z] $= \frac{\text{score} - \text{mean}}{\text{standard deviation}}$	• Secondary or primary data on pupils' test scores in some subjects. • Lesson Plan Manual	• Standard questions on standardised scores.

References and resources

- Vanguard
- A4 Cards
- Statistics Sierra Leone website
- Newspapers
- Magazines
- Advertisement Leaflets
- Compasses and Rulers
- Secondary data from internet and other sources e.g., Statistics Sierra Leone
- Graph paper
- Permanent markers
- Coloured pencils
- Coins
- Dice
- Counters
- Lined paper
- Match boxes