The New Senior Secondary Curriculum for Sierra Leone

Subject syllabus for Introductory Statistics and Probability
Subject Discipline: Social and Cultural Studies

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 Introductory Statistics and Probability an everyday 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.

Introductory Statistics and Probability takes a practical approach where students carry out statistical investigation on issues of the day and gives them a sense of how statistics fits into everyday Mathematics.

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

The world is a data-driven world and Sierra Leone is no exemption. As was seen in the Coronavirus pandemic, decisions by health authorities are all data-driven.

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.

General learning outcomes and broad goals

As a result of studying this course, pupils should

- Be able to make sense of the data in their lives
- Be able to make better sense of the news they get and what they see in their communities
- Get a better understanding of information received from various sources and workplaces
- Be less easily manipulated by misleading data in statements or representations

Subject content outline (Themes and topics to be covered)

SS1

- Definition of data and types of data
- Representation of data
- Grouping Data
- Statistical measures – introduction to averages
- Sampling
- Statistical investigation

SS2

- Databases
- Probability - basics
- Statistical measures – working with averages
- Stem and leaf diagrams
- Scatter graphs and correlation
- Scatter graphs and correlation
- Scatter graphs and correlation
- Further representation and interpretation of data (1, 2, 3)
- Misleading data, presentations and statements
- Tabulation and curves

SS3

- Theoretical and experimental probability
- Statistical investigation
- Statistical investigation – continued
- (Review and revision)

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 **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	**Databases** • Construction and Interpretation **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	**Theoretical and experimental probability** • Theoretical probability • Experimental probability/relative frequency • Mutually exclusive events • Expected frequencies **Statistical investigation**
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. **Statistical measures – introduction to averages** • Concept of average for data in form of a list or a frequency table	**Scatter graphs and correlation** • Scatter graphs • Positive, negative and no [zero] correlation • Lines of best fit • Interpolation • Extrapolation **Further representation and interpretation of data (1, 2, 3)** • Comparative pie-chart • Interquartile range of discrete dataset • Box and whisker plots	**Statistical investigation – continued (Review and revision)**

	• Mean, median, mode and range for discrete data set • The advantages and disadvantages of using mean, median and mode		
Term 3	**Sampling** • Sampling methods • Random sampling • Systematic sampling **Statistical investigation** • (End-of-Year Mini Project – 4-6 weeks)	**Misleading data, presentations and statements** **Tabulation and curves** • Cumulative frequency curve from grouped discrete data • Estimating median and interquartile range	**(Review and revision; examination)**

Teaching Syllabus

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
Representation of data • Pictogram, bar charts, pie charts, two-way tables, time series graphs	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.	• Display various charts as seen in real life situations E.g., newspapers (Awoko Business section, https://awokonewspaper.sl/category/business-finance/, advertisements, magazines, websites. • Get pupils to identify charts and discuss amongst themselves	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?

• Using appropriate methods of tabulation to enable the construct of statistical diagrams • Interpreting statistical diagrams	• Complete and answer questions from two-way tables. • Draw a time series graph and describe changes over a period of time.	before asking them to share with the whole class their understanding of the charts and what information they can draw.		• 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	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.

• 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	By the end of this topic, pupils will be able to: • Calculate mean, median, mode and range for discrete data set. • Examine data and identify extreme values [outliers]. • State the respective advantages and disadvantages of using mean, median and mode.	*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 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		• Standard questions on mean, median, and mode. *Problem solving* • Find a set of five positive whole numbers with: - Range 10 - 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.

		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.		
Sampling • Sampling methods • Random sampling • Systematic sampling	By the end of this topic, pupils will be able to: • Construct a sample in a small group chosen to represent the larger population. • Select a simple random sample by drawing names from a hat or by using random button on a calculator	*Teacher-led discussion and explanation* • What a sample is • The practicalities of sampling • Random sampling • Systematic sampling *Questions and answers* • What is a census? • What is a survey? • What is an appropriate sample size?	Secondary data, e.g. pupil class list Calculator	*Discussion* • Why do surveys often use a sample instead of the whole population? • Why did you decide to use a systematic sampling instead of a random sampling?
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 - Collecting the relevant data - Processing and representing the data.	*Teacher modelling and suggestions on Problems to be investigated* *Examples:* • Girls do better at Maths than boys • More men die of Corona Virus than women • More women wear facemasks than men	Different sources of secondary data Internet Graph paper Measuring Instruments Lined paper Plain paper	• 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.

	- Interpreting, discussing, comparing and making predictions	• On average, boys are taller than girls • Prices of goods at Krootown Road market are higher than prices of the same goods at Congo Market	Coloured pencils / crayons	• 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
Databases • Constructing databases • Interpreting databases	By the end of this topic, pupils will be able to: • Design a database on paper and using ICT. • Answer questions on a database	• Present databases to students in small groups and ask them to discuss their understanding of databases.	Examples of databases	• Construct a database of some pupils in your class. You can include as many fields as you can, e.g., name, age, favourite colour, number of siblings, pets, with or without mobile phone. • Examine the database. • Draw up as many questions as you can to pose to your friends to answer.
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	• 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

	occurring from a sample space diagram.			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 compare two distributions.	• 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. • 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.	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 stem and leaf diagram. Write as many differences and similarities as you can see between the two data sets.
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.'	*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.	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

	• 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.	• 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 the data given) and Extrapolation (predicting data values outside the range of the data given)		- 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 from your friends? Explain • How would you spot outliers from your scatter graph?
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 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?	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 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	By the end of this topic, pupils will be able to: • Find the interquartile range of discrete data using upper and lower	• 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	Standard questions on Interquartile range.	• Pupils answer standard questions on Interquartile range. *Probing questions*

• Interquartile range of discrete dataset	quartiles and why it is a better measure of spread than the range.	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) • 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.		• 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 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 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.	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?
Misleading data, presentations and statements	By the end of this topic, pupils will be able to: • Explain that statistical diagrams can be used	*Teacher modelling* • Bar charts not showing the origin on the frequency scale.	Internet	• Pupils answer standard questions on 'misleading' information. *Probing questions*

	to present evidence to suit the point that someone wants to make. • Interrogate a statistically claim and decide whether or not it is misleading	• 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. • 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.		• 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? • 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.
Tabulation and curves • Cumulative frequency curve from grouped discrete data • Estimating median and interquartile range	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, Interquartile range and semi-interquartile range.	*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 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?

Senior Secondary Level 3

Topic/Theme/Unit	Expected learning outcomes	Recommended teaching methods	Suggested resources	Assessment of learning outcomes
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.
Statistical Investigation	By the end of this topic, pupils will be able to: • Investigate a statistical problem of their choice	• Support students to structure their written work.	Paper Secondary data Internet ICT facilities	Students show they are 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.

References and resources

- Vanguard
- A4 Cards
- Statistics Sierra Leone website, *Statistics Sierra Leone,* http://www.statistics.sl/
- Newspapers
- Magazines
- Advertisement Leaflets
- Compasses and Rulers
- Secondary data from internet and other sources
- Graph paper
- Permanent markers
- Coloured pencils
- Coins
- Dice
- Counters
- Lined paper
- Coloured pencils
- Match boxes