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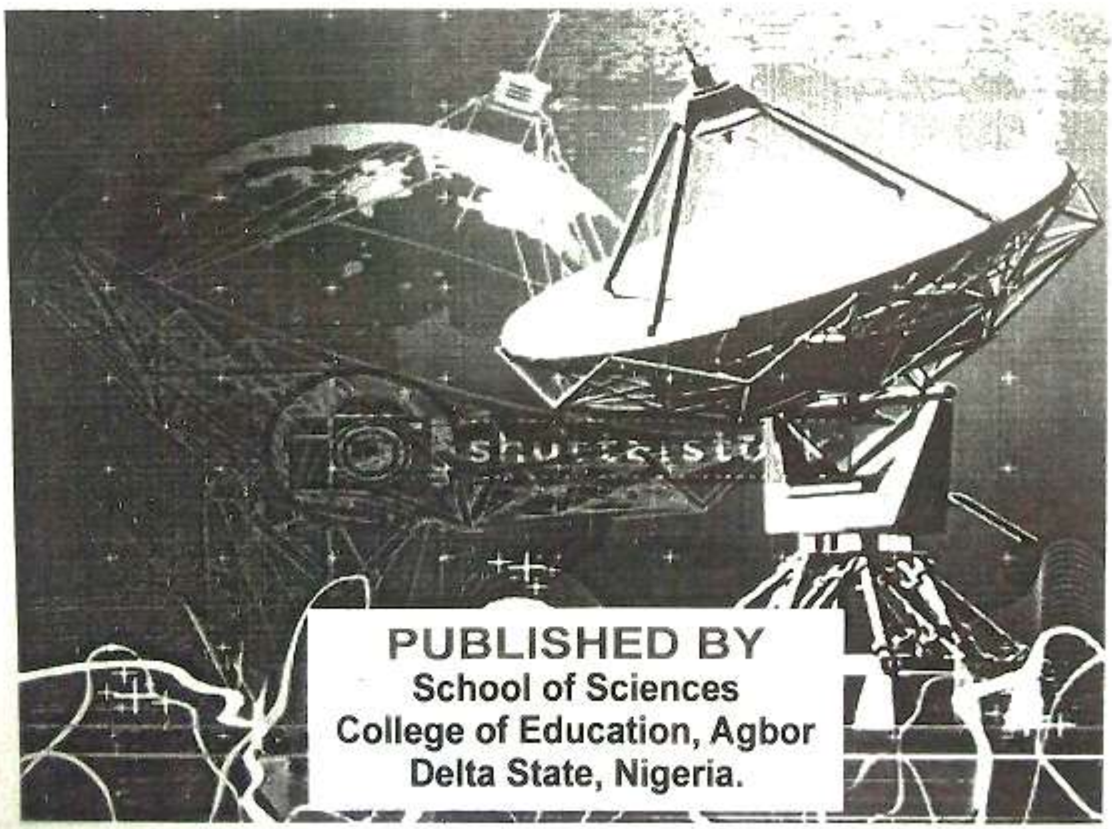

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IMPROVING STUDENTS PERFORMANCES IN STATISTICS AND PROBABILITY AT THE SENIOR SCHOOL CERTIFICATE EXAMINATION

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ABSTRACT

Question on probability and statistics feature in the senior certificate examinations from year to year. Yet performance of candidate at these examinations does not seem to improve with the passing years. The scripts display an appalling lack of knowledge of the basic concepts and methods required. In this paper, attention is drawn to the most important aspects of the Senior School Certificate Examination requirement in the statistics and probability component of the Mathematical syllabus. I also highlight the little, crucial details, usually taken for granted or forgotten in the rush to finish the syllabus by teachers preparing students for the examination. These details needs to enhance performance. Finally I need give complete solutions to a few selected past examination questions to illustrate the concepts and methods.

INTRODUCTION

It has been discovered that studies perform poorly in Mathematics in the Senor School crepitate examination. The reason for this has been attributed to many factors. The mathematics syllabus has different parts and the part that looks simple and easily applicator to everyday situations in statistics and probability Question on this area is found every year and would be enough to lift student's performance to better the grade in all this important subject.

It is a truism that without credit in mathematics, gaining admission to higher institution of learning is virtually impossible. There is equally no area of life whose it is not useful. The need therefore arises to proffer solution that would place students in a better pedestrian to credit mathematics in their final examination.

The performance in the Senior School Certificate Mathematics Examinations byParents are worried stiff about this state of affairs. Recently, there have been persistent calls to these concerned parents as well as the discerning general public for both schools and government to do something to arrest the deplorable situation.

Many reasons have been put forward to account for the poor performance in Mathematics in our secondary schools. Some people blame the students; schools in Delta State have not been gratifying.

It is not the wish of this paper to determine the reasons for the poor performance. Rather the paper is an effort to remind teachers of the key points in the statistics and probability component of the Mathematics Syllabus. We submit that when students are properly taught they would be better equipped for the examinations and are less likely to resort to examination irregularities. Performance will improve correspondingly.

In this presentation, we shall address the statistics and probability components of the Senior School Certificate t, lamination syllabus. The aims of the Mat!

The understanding o' Mathematical concepts and their application to everyday living.
The ability to recognize problems and to solve them with related Mathematicalknowledge.
The ability to be accurate to a degree relevant to the problem at hand.
Precise, logical an abstract thinking.

The specific topics in the syllabus!,labus concerning statistics and probability are as follows:

Statistics

Frequency distributions.

Pie charts, bar charts, histograms and frequency polygons
Mean, median and mode
Cumulative frequency
Measures of dispersions range, inter-quartile range, mean deviation and standard deviation.
Experimental and theoretical probability,
Addition and multiplication rules of probabilities,

From our experience the major problem in statistics is with grouped data. Probability on the other hand does not seem to be understood by a good number of candidates. We are convinced though that a sound understanding of the sample space and events of an experiment holds the key to a complete mastery of the probability component of the syllabus. Our discussion henceforth will consequently concentrate on these areas.

STATISTICS

GROUPED FREQUENCY DISTRIBUTIONS

When dealing with a large amount of data, it is useful to group the information into classes. Each class is called a class interval. The following arrangement of data into class intervals is called a grouped frequency distribution.

Class	30-34	35-39	40-44	. 45-49	50-54
Frequency	4	9	14	8	5

Table 1

CLASS LIMITS AND CLASS MARKS

30-34, 35-39, … are called class intervals and 30, 34, 35 39 the class bounding whole 30.5, 345, 39.5… are clan into. 30 and 34 are the have and upper clan bounding while 37, 47, 47 by *lowerclasslimit+upperclasslimit* is called the class mark .

PICTORLIAL REPRESENTATION OF DATA

1-THE SIMPLE BAR CHART.

The bar chart consists of a series of bars all of the same width. The height of each bar represents the frequency of the item or class. The bars are separated apart on equal. Example

Use a bar chart to represent the information given in table 2 below:

Type of personnel	Unskilled workers	Craftsmen	Draughts men	Clerical staff
Number Employed	45	25	5	10

Table 2

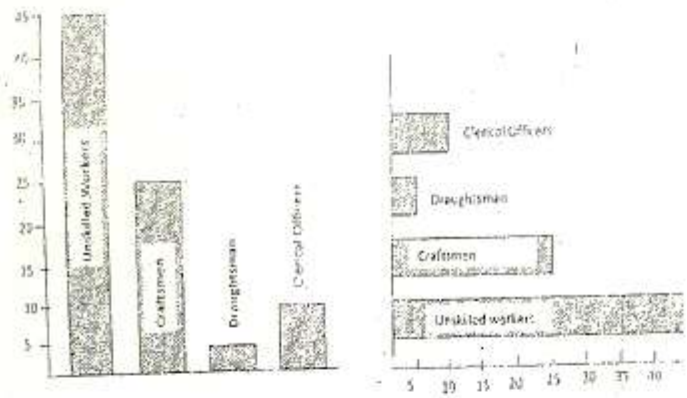


Fig. 3 Bar Charts

THE PIE CHART

The pie chart is suitable for representing data in which the number of items is not much - usually not greater than five. It consists of a circle divided into sectors. The angle subtended at the centre is proportional to the frequency of the item represented by the sector. In calculating the angles one only has to remember that the angle in a circle is 360°.

As an example let us represent the data of table 2 by means of a pie chart.

As an example let us represent the data of table 2 by means of a pie chart.

Angle corresponding to unskilled workers $\frac{45}{85}\ x\ \frac{360}{1} = 191^0$

Angle corresponding to craftsmen = $\frac{25}{85}\ x\ \frac{360}{1} = 106^0$

Angle corresponding to Draughts men = $\frac{5}{85}\ x\ \frac{360}{1} = 21^0$

Angle corresponding to Clerical staff = $\frac{10}{85}\ x\ \frac{360}{1} = 42^0$

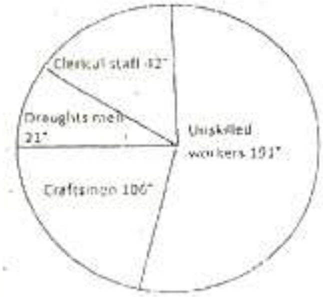
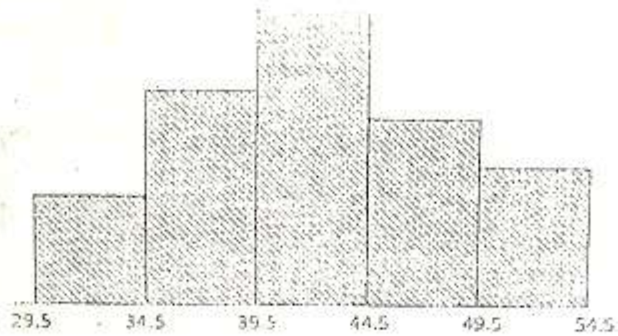


Fig 4 Pie chart.

THE HISTOGRAM

Another diagram used to represent a frequency distribution is the histogram, it consists of a set of rectangles whose areas represent the frequencies of the various classes. Each rectangle is constructed in such a way that the class mark of each class corresponds with the centre of the rectangle whereas the sides of the rectangle coincide with the class boundaries. In labeling a histogram it is preferable to indicate the class boundaries. Sometimes it is enough to label the class marks.

Example: Draw a histogram to represent the data of table 1. Hence obtain the mode of the distribution.



If the class widths are all equal, the height of each rectangle is proportional to the frequency of the class interval. When the class widths are unequal, the heights of the rectangles must be adjusted correspondingly since the frequencies are represented by the area of the rectangle.

However, most of the questions set have assumed equal class widths for the class intervals.

CUMULATIVE FREQUENCY DISTRIBUTIONS. OGIVES

The total frequency of all values less than or equal to the upper class boundary of a given class interval is called the cumulative frequency up to and including that class interval or simply the cumulative frequency of the interval. A table presenting cumulative frequencies is called cumulative frequency distribution.A graph of cumulative frequencies, plotted against upper class boundaries is called a cumulative frequency polygon. A smoothed cumulative frequency polygon is called a cumulative frequency curve or an ogive.

PROBABILITY

Lipschutz (1974) defines probability theory as the study of random events i.e. events whose outcome cannot be predetermined. Hence probability is that branch of statistics which tries to quantify the possibility an event has for occurring out of a number of similar or related events. The chance associated with the occurrence of an event is determined by the number of similar or related events that are competing for occurrence, and the weight associated with each of these events. (c) (d).

For instance in the toss of a coin, has a sample spacetwo, events - the head and tail - are in exclusive contest and there is no third event. If the coin is fair (or unbiased), then both events have equal probability of occurrence.

The Sample Space

This is the set of all possible outcomes of an experiment. This may be likened to or compared with the universal set in set theory. It might be called the 'mother set' for every possible outcome.

An event is a subset of the sample space; it may be just an outcome, or a group of related outcomes.

In experimental probability, emphasis should be on

ii) Ability to identify and list out the members of a sample space.

ii) Ability to identify the total number of points or weights associated with each points of the sample space.

I. Ability to identify all the outcomes in a given event,

II. Ability to identify the number of points associated with a givenevent.

When this is done, then, probability is reduced to a ratio between two numbers.

The probability of an event A of a sample space S is $\frac{n(A)}{n(S)}$ —— where n (A) means the numberof points in A and n(S) the number of points in the sample space S.

ILLUSTRATION

(a) In the toss of a fair die, the possible outcomes are 1, 2, and 3,4,5,6. Hence the samplespace is the set S= {1, 2, 3, 4, 5, and 6}

There are six distinct elements in S, each with equal chances of occurrence because the die isfair, so each element has a sample point. An event in this sample space could be

The occurrence of 3 = n (3)?

The non-occurrence of 3 is the occurrence of (1, 2, 4, 5, 6),

The occurrence of an even number (2, 4, 6),

The occurrence of an odd numbers (1, 3, 5),

The occurrence of a prime numbers (2, 3, 5),

Example

Two balls are to be picked with replacement from a bag containing 3 red and 6 black balls. What is the probability that (i) Both are the same colour?

i. Both are different colours?

ii. Both are red?

Solutions:

Implied meanings are:-

In (i) for both to be of the same colour then both are either red or black i.e. the first selection is red <u>AND</u> the second is also Red OR

The first is Black And the second is black.

The underlined words implied by the question.

To provide a solution, S= (3R, 6B)

No of red balls = 3, no. of black balls = 6 Total number of balls = 9.

$\therefore P(R) = {}^3/_9 = {}^1/_3$ P $P(B)^6/_9 = {}^2/_3$ =

P(both are of same colour) = P(R and R or B and B)

=P(R) x P(R) + P(B) x P(B)

$= {}^1/_3 \times {}^1/_3 \times {}^2/_3 \times {}^2/_3$

(ii) Both can be of different colours if the first is red AND the second is black OR the first black AND the second is Red P (both are of different colours)

= P (R AND B OR B AND R)

= P (R) x P (B) + P (B) x P (R)

$= \frac{1}{3} \times \frac{2}{3} + \frac{2}{3} \times \frac{1}{3} \times \frac{1}{9}$

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Finally we must be careful to exhaust all the possibilities before arriving at our final answer. To the question: What is the probability of picking a red ball and a black ball? The answer is not just P (R) x P (B), because there are also two ways in which this can happens namely picking a red first selection and a black at the second or picking a black at the first selection and a Red at the second. Hence the actual solution will begin with P (a red and a black)
= P (R and B or B and R)
= P (R) x P (B) x P (R) and so on.

Sampling without Replacement

This is another area where emphasis is needed in the senior secondary curriculum. If a bag contains a given number of marbles of the same size, but different colours, and a number of them are to be selected, one after the other, from the bag, then, what happens to each selected marble is of importance to us. If after a selection, the selected marble is inspected, the colour noted and then it is returned into the beg before the next selection this is referred to as sampling with replacement. If, the other hand, a selected marble is not to be returned before the next selection, then the procedure is called sampling with replacement.

In the case of sampling without replacement, we must observe that at each samplingthere is a

i. Reduction in the size of (no. of points in) the sample space by 1 or the number of marbles to be picked at once.
ii. Reduction in the size or number of points associated with the colour that is picked.
iii. A difference in probabilities between successive stages of selection.

Example

A box contains 2 white and 3 blue identical marbles. If two marbles are picked at random, once after the other, without replacement, what is the probability of picking.

i. two marbles of different colours
ii. two marbles of same colour

Solution:

S = (2W, 3B)

i. Picking two marbles of different colours implies picking one white and ope blue, andthis may come in any order. That is, by picking a white first artd the blue or blue first and then white

P (1^{st} is white) = $\frac{2}{5}$

P (2^{nd} is blue) = $\frac{3}{4}$

∴ P (1^{st} is white AND 2^{nd} is Blue) = $\frac{2}{5} \times \frac{3}{4} = \frac{3}{10}$

P(1^{st} is blue) = $\frac{3}{5}$

P (2^{nd} is white) = $\frac{2}{4} \times = \frac{1}{2}$

∴P (1^{st} is Blue and 2^{nd} is white) = $\frac{3}{5} \times \frac{1}{2} \times \frac{3}{10}$

P (Two marbles of different colors) = $\frac{3}{10} + \frac{3}{10} = \frac{3}{5}$

iii) in picking two marbles of the same colours, then both must be blue or both white.

P (both are blue) = P (1^{st} is blue and 2^{nd} is blue) = $\frac{3}{5} \times \frac{2}{4} = \frac{3}{10}$

P (both are white) = P (1^{st} is white and 2^{nd} is white) = $\frac{2}{5} \times \frac{1}{4} = \frac{1}{10}$

P (both are of the same colour) = $\frac{3}{10}$ x $\frac{1}{10}$ = $\frac{2}{5}$

EXAMPLE

From a bag containing 3 red and 4 white balls, three balls are to be picked one after the other without replacement. Write out the sample space for this experiment and find the probability that

i. All three are white
ii. One is white and the others red.

Solution:

S = (RRR, RRW, RWR, WRR, RWW, WRW, WWR, W W W)

Note that there are eight events, but they are not equally likely.

i. Without replacement P (all three are white) is same as prob (1^{st} is white and 2^{nd} is white AND 3^{rd} is White)
ii. P(one is white and the others red)

=P (WRR or RWR or RRW)

$= \frac{4}{7} \times \frac{3}{6} \times \frac{2}{5}$ or $\frac{3}{7} \times \frac{4}{6} \times \frac{2}{5}$ or $\frac{3}{7} \times \frac{2}{6} \times \frac{4}{5}$

ILLUSTRATERIVE EXAMPLES

1. The table shows the score of 2,000 candidates in an entrance examination into a private secondary school.

% Mark	11-20	21 30	31-40	41-50	51-60	61-70	71-80	81-90
Number	68	184	294	402	480	310	164	98

(a) Prepare a cumulative frequency table and draw the cumulative frequency curve for the distribution.

iv) Use your curve to estimate the
III. Cut off mark if 300 candidates are to be offered admission
IV. Probability that a candidate picked at random scored at least 45%.

Solution

(a) Cumulative frequency table

% Mark	class	20.5	30.5	40.5	50.5	60.5	70.5	80.5	90.5
Number	of	68	252	546	948	1428	1738 &	1902 , 0	2000 ¹

For cumulative frequency curve see graph 1.

(b) i) note that if 300 candidates are offered admission then the lower 1,700 candidates were rejected. We then find the score corresponding to cumulative frequency of 1,700. On the graph this is 69%

From the graph, the number of candidates that scored below 45% is 740.

No, of candidates scoring at least 45% = 2000 - 740 =1,260 hence prob. That a candidate 1260
63

Picked at random scored at least 45%

A box contains 5 blue balls, 3 black bails and 2 red balls of the same size. A ball is selected at random from the box and then replaced. A second ball is then selected.

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Find the probability of obtaining

a) Two red bails

b) Two blue balls or two black balls

c) One black ball and one red ball in any order.

Solution The main thing to remember here is that the first ball selected is replaced before the second is selected. Therefore the probability of selecting a black ball at the first try is the same as the probability of selecting a black ball at the second attempt. This probability is

$= \frac{3}{3+5+2} = \frac{3}{10}$

Similarly ,)f picking a red ball is $\frac{5}{10} = \frac{1}{5}$ attempt and the probability of picking a blueat any attempt is $\frac{5}{10} = \frac{1}{2}$

The events are also independent as the ball picked at the first trial does not affect the ball picked at the second trial.

Let B be event blue ball is picked, b, black ball is picked and r, red ball is picked Then (a) prob that two red balls are picked prob that two blue balls are picked $= \frac{1}{5} \text{ x } \frac{1}{5} = \frac{1}{25}$ or 0.04.

(b) prob that two black balls are picked $\frac{1}{2} \text{ x } \frac{1}{2} = \frac{1}{4}$

prob that two blue or two black balls are picked $= \frac{3}{10} \text{ x } \frac{3}{10} = \frac{9}{100}$

(c) Pr. 1^{st} ball is black and 2^{nd} ball isred $= \frac{3}{10} \text{ x } \frac{2}{10} = \frac{6}{100}$

Pr. 1^{st} ball is red and 2^{nd} ball is black = $\frac{2}{10} \text{ x } \frac{3}{10} = \frac{6}{100}$

prob of one black and one red in any other $= \frac{6}{100} + \frac{6}{100} = \frac{12}{100} = 0.12$

5.0 SUMMARY

The work has looked thought some topics in statistic and prodigality of the SSE mathematics scheme. Therequire for the preceded difficulty of the area by students are identified. Effort has been made to bring to bear the teachings that will ensure early understanding of the concepts. Illustrate explain have been give with compounding explanation/direction in how to solve them.

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