Assessment Report

Scholarship, 2008

Statistics and Modelling

COMMENTARY

Overall, Questions 1 and 5 were the best answered, with Questions 2 and 6 being not so well answered.

However poor candidate performance was not generally caused by wording, layout or validity of the questions themselves, but through candidates misinterpreting the problem, selecting inappropriate methods to solve the problem and not fully meeting the requirements of the problem in their answers - for example, omitting assumptions when they were clearly asked for. They often simply generalized, for example "take a 95% confidence interval and if zero is not in the interval there is a difference" was their answer to Question 1(c) without any detail being given which related to the question.

Overall, candidates appeared better this year at setting out their answers, even when using graphics calculators, to clearly indicate their method. There were few cases where part marks could not be awarded because of a lack of evidence provided by candidates through the use of graphics calculators. Candidates need to check their calculations. Calculator key strokes should not form part of any answer and are not considered to be valid mathematical working.

Successful candidates were able to use statistics correctly in their explanations and observations and they did not repeat themselves. They read the questions properly, and gave clear statistical statements in their answers. They wrote down all the points that were required. A full coverage of the information contained in graphs and tables was clearly articulated. They were able to write clearly and demonstrate their thoughts in a coherent, cohesive, sensible, detailed and complete manner. Their overall presentation and logical development of their answers, on the whole, was very good.

The instructions on front cover stated "start each question on a new page". Several candidates ignored this and in some cases the candidate's work was so muddled that it became difficult to find the answers to questions.

Many candidates failed to use their basic statistical knowledge. They failed to comment in English on graphs and tables which were at NCEA levels 1 and 2. Candidates need to be made aware that it is imperative they read the question three or four times to make sure they are answering the question they are asked, not the question they would like to answer. An example of this was in calculating the sample sizes in Question 2(b) where some information was available so p did not need to be taken as 0.5.

The best-performing candidates most commonly demonstrated the following skills and/or knowledge:

- ability to compare and contrast and to elaborate and articulate in context; when they said that the standard deviation for expenditure for standard rooms was $4.40 and for deluxe rooms was $46.37 they could explain what this meant in terms of variability
- ability to manipulate algebraically, as was required in Question 5(d)
- understanding of the differences in sampling methods and ability to describe processes such as taking a systematic sample in Question 2(a)
- ability to show a logical way of thinking in the presentation of their answers; very few of their answers came from nothing; steps were written down and thus clear mathematical thinking was demonstrated when finding probabilities, optimal solutions and predictions
- ability to interpret and graph the step function in Question 6
- ability to calculate and justify their methods in Questions 1(b), 2(b) and 3(c)

- ability to demonstrate their experience with planning and evaluating the different stages of a statistical investigation by:
  - seeing the importance of selecting a random sample that is representative of the target population
  - knowing the features of the systematic sampling method, including describing clearly how to use it in order to select a sample along with its associated advantages and disadvantages
  - planning what data needs to be collected and what will be done with it
  - selecting appropriate methods for analysis, which determining assumptions that need to be made in order to use that method
  - using the results of pilot studies to inform future investigations – e.g. in the consideration of minimum sample sizes and the representativeness of samples
  - making generalizations/inferences from an analysis – e.g. by interpreting the results of a confidence interval for the difference of two means
  - giving consideration of other related factors to the area of investigation that would allow a more in-depth analysis by identifying probable numerical variables that may account for the variability seen in the data
- ability to display excellent understanding of sampling variability and confidence intervals by:
  - constructing and interpreting confidence intervals appropriately in order to evaluate claims about a population parameter
  - identifying the components of the confidence interval – e.g. margin of error, level of confidence and the setting up equations to find the minimum sample size
  - demonstrating understanding of the central limit theorem where necessary – e.g. appropriate sample sizes, assumptions regarding standard deviation for constructing confidence intervals and considering sample proportions and the conditions under which they would approximate by a normal distribution
  - choosing correctly whether to solve a problem using a confidence interval (where a sample situation had been clearly described) or an appropriate probability distribution or equivalent method (where a random variable situation has been clearly described); in both cases, sampling variation was taken into account
- strong algebra and graphing skills, and flexibility in their linear programming methods
- ability to analyse bivariate and time series data by:
  - relating tables of data, displays, and models provided (including values of R^2) to each other to identify, describe and quantify (where appropriate) the key features of the variables and any relationships between them
  - discussing the selection of a model based on more than just the numerical value of R^2 – e.g. using visual, contextual/sensible approaches and consideration of what R^2 measures
  - comparing the suitability of models for the trend for time series data, including piece-wise models
  - calculating average seasonal effects from raw and smoothed data and using them in making forecasts
- ability to select and use probability methods by:
  - identifying when a situation could be modeled by an appropriate probability function
  - if approximations were used, knowing the conditions required for making approximations and ensuring continuity corrections were made if needed
  - identifying conditional statements and drawing/using trees or diagrams appropriately to solve problems involving conditional probability

  - modelling situations involving an unknown probability where an equation had to be set up using probability formulae and solved algebraically by hand or with graphics calculator
- demonstrated effective communication as evidenced by their answers to Questions 1(c), 2(a), 3(a), 3(c) and 4
- ability to show high-level critical statistical thinking as evidenced by their answers to Questions 2(b) and 6
- ability to produce very detailed and well presented answers.

Candidates who did NOT achieve scholarship lacked some or all of the skills and knowledge above and in addition they:

- left out the details required in Question 1(c) and could not describe a simple sampling process; they could not distinguish between finding the differences in the mean amount per diner and finding the differences in the means of the amounts spent; rather than sampling the diners, they wanted to sample the means for each night, so essentially could not identify the target population
- could not work out the inverse z-score so when the confidence level was given as 99% they used values other than 2.576
- did not use all of the information given in a question to give a full answer, so in Question 4 they did not write about the mean and standard deviation and what these measures represented when comparing the expenditures over the two types of room
- wrote vague, unclear and irrelevant comments when discussing differences – e.g. in Question 1 they wrote "It's assumed the 'diners' are independent" or "calculate the difference between the two means" rather than find the confidence interval for the difference in the mean amounts spent
- could not carry out algebraic manipulation
- lacked the ability to interpret information in tables and graphs
- showed a lack of detail in explanations and essay writing with basic statistical understanding not being utilised before higher level knowledge was applied
- wrote about possible reasons for the features of the data rather than demonstrating their understanding of the statistical features by making speculative rather than analytical/contextual based comments
- applied methods inappropriately or incompletely – e.g.
  - using a difference of two means confidence interval in Question 1(b)
  - using a hypothesis test in Question 1(b) but not stating whether it was one- or two-tailed
  - using a confidence interval to answer Question 2(c)
- presented answers that did not make sense by reflecting a lack of statistical understanding and thinking required at this level by:
  - giving probabilities larger than one or less than zero
  - giving answers like "building 65 deluxe rooms" when they cost the most to make
  - discussing forecasts and not taking into account seasonality
- failed to relate their generic answers to the question, especially in Questions 2 and 6 where the questions were slightly different from the way they may have seen them; the answers needed to be related to the context of the questions – e.g. stating that mean *a* is larger than mean *b* but not giving any contextual explanation of the difference in these means
- incomplete understanding of evaluating regression models – e.g.
  - discussing R^2 without context or incorrectly
  - basing selection of models simply on which R^2 value was higher

- discussing validity of predictions by comparing them with individual points in the data
- discussing the standard deviation of a single variable (e.g. deluxe room expenditure) with reference to the scatter around the fitted line for a bi-variate model.