Examiners' Report
Principal Examiner Feedback

Summer 2024

Pearson Edexcel GCE
In Further Mathematics (8FM0)
Paper 23 Further Statistics 1

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Introduction

This paper provided accessibility for all students with most making some progress in each of the 4 questions. There were a number of places where students were required to comment and many did so generically rather than using the context provided in the question. In general, students work to an appropriate degree of accuracy but sometimes premature rounding lost accuracy marks. Students are reminded that when a calculator is used instead of the statistical tables provided, the values should be quoted to at least the same degree of accuracy as the values in the tables.

Report on Individual Questions

Question 1

The vast majority of students made good progress in this question and answered the numerical sections accurately, securing full marks on (b), and (c). Occasional method errors in (b) usually involved some sort of average of the 3 observed frequencies. In (d), the correct critical value was stated in almost all responses, although a small number of students lost a mark for not giving this value to the required degree of accuracy as specified on the front of the examination paper. It was rare for students to select the wrong critical value for their stated degree of freedom.

In part (a), a large number of students had difficulty expressing the hypotheses in a correct way for a test of independence, with a simple restating of the question being the most common wrong response. Reference to correlation was also common, whilst a significant minority of responses had the hypotheses the wrong way round. Responses which scored the mark were those which referred to independence or association and were usually expressed in a clear concise way. In part (d), the statement of the conclusion could use less specific phraseology and so more students earned this than the mark in (a). Some students lost this mark by confusing the test statistic and the critical value and so drawing an incorrect conclusion, because their initial hypotheses were reversed, or because their conclusion contained contradictions. Many misinterpreted that rejecting H_0 meant that games were preferred equally by all age groups.

Question 2

This question required students to give answers in context which they often find difficult. Accuracy was also an issue in part (b)(iii).
Part (a) was generally answered well but some students failed to relate their answer to the context (accidents) of the question. Common incorrect responses included referencing assumptions relating to the binomial distribution (constant probability).
Part (b)(i) was a good source of marks for most students.
In part (b) (ii) the new value of lambda was generally correct and also stated, when the answer was not correct a common error was calculating $P(X \leq 9) = 0.704$ rather than the correct answer of $P(X \leq 10) = 0.806$
In part (b) (iii) it was pleasing to see the correct new model being stated before attempting to calculate P(at least 2 months). Common incorrect methods involved either calculating $P(X > 2)$ or using a Poisson approximation rather than the exact binomial distribution. Many lost the final accuracy mark due to premature rounding which meant their final answer was not to the required level of accuracy.
There were some good attempts at part (c) with many students clearly understanding the assumptions required to model using a Poisson distribution – accidents having to occur independently of each other or singly. However, many then confused this and stated that the manager should record this as two accidents (since accidents cannot happen at the same time).

Finally, in part (d) the correct hypotheses with the required parameter stated were a common occurrence. A small number of students used p rather than λ or μ
Most students were able to appreciate the requirement to calculate a p-value using $P(X \leq 22)$ but there are still students who are incorrectly calculating $P(X = 22)$.
Those students who used the given wording in the question were generally most successful. Far too many referred to the number of accidents reducing rather than it being the rate of accidents or number of accidents per month.

Question 3

Many fully correct responses were seen to this question. Virtually all students found r and p correctly. Some then went on to make a slip when using these values to find the required expectation but were at least able to pick up the final method mark by showing their working clearly. Some attempted to find $E(X)$ then and 1 and square root this.

Question 4

This question tested all aspects of goodness of fits tests and many were able to make some headway with parts (a) and (d) providing discrimination at the top end. In part (a) most students were able to score 1 out of 2 marks. Those who scored only 1 mark were able to explain that the probability of the arrow hitting the target was constant or by giving two comments not in context mentioning the key words.
The concept of independence was not well understood and there were few comments that explained this concept and quite a significant number of explanations talked about the probabilities being independent and not referring to the 'hits,' 'shots' , 'arrow being shot.'
A significant number of scripts could not use the mathematical language, such as 'probability' and 'independence' in their answers and often gave an explanation which implied these and so could pick up 1 mark.
Part (b) was a successful part of the question with most scoring full marks, though we allowed the mark to be picked up in part (c) for those only calculating the mean in this part but who went on to use 0.36 in the subsequent work. The reason for losing a mark here was a mistake made in calculating the expectation or by dividing by 100 and not 800.
Again in part (c) many good solution were seen with most students picking up full marks. Those that did not earn full marks, made errors like:

- choosing a Poisson model and then using it throughout the question
- correctly choosing a binomial model (so earning the first two marks) and then going to use a Poisson Approximation to work out the expected values
- giving values that were outside either of the ranges
- the sum of their expectations did not add up to 100 or awrt 100.01

Part (d)(i) saw a mixed response with most students picking up 1 of the two marks. Errors made were:

- not being specific enough and saying that it was the expected values being pooled as the $E_i<5$ or needed to be such that all $E_i>5$
- referring only to frequencies, rather than expected frequencies
- referring to 2 constraints but not explaining what they were
- combining more cells than necessary to arrive at 3 degrees of freedom

Many took the clue from the degrees of freedom given and were able to make a good start at part (d)(ii). This was a good discriminator with more able students able to pick up most marks. Less highly performing students were still able to earn the mark for finding the correct critical value.
The main reasons for losing marks in the question were:

- stating hypotheses incorrectly either 'having them the wrong way round' or referring to $p = 0.36$
- incorrectly pooling either '0 and 1' or '5,6,7 and 8' or not showing these clearly enough
- not pooling '0 and 1'
- mistakes in $\frac{(O_i-E_i)^2}{E_i}$ or $\frac{{O_i}^2}{E_i}$ values, having them the wrong way round or not giving enough accuracy
- writing down an incorrect value of the test statistic with no supporting working

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