UNIT 4: Statistical Distributions **Use discrete distributions to model real-world situations; Identify the discrete uniform distribution; Calculate probabilities using the binomial distribution (calculator use expected) (4.1)**	**Teaching time** 5 hours

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SPECIFICATION REFERENCES

4.1 Understand and use simple, discrete probability distributions (calculation of mean and variance of discrete random variables is excluded), including the binomial distribution, as a model; calculate probabilities using the binomial distribution

PRIOR KNOWLEDGE

An understanding of probability from the previous unit and the awareness that the area under a curve will be looked at again in this unit.

GCSE (9–1) in Mathematics at Higher Tier

N1 Order positive and negative integers, decimals and fractions; use the symbols =, ≠, <, >, ≤, and ≥

KEYWORDS

Binomial, probability, discrete distribution, discrete random variable, uniform, cumulative probabilities.

OBJECTIVES

By the end of the sub-unit, students should:

- understand and be able to use simple, discrete probability distributions, including the binomial distribution;
- be able to identify the discrete uniform distribution;
- be able to calculate probabilities using the binomial distribution.

TEACHING POINTS

Students will be expected to model real-world situations by using simple discrete probability distributions. They should know and be able to recognise a discrete uniform distribution; look at equally likely outcomes such as numbers on a dice.

The only specific distribution students are expected to use as well as understand is the binomial distribution. Students will be expected to comment critically on how appropriate a given probability model may be for a situation.

The notation $X \sim \mathrm{B}(n, p)$ may be used, so you should ensure students are familiar with this from the outset. Make sure the properties of the binomial are clear for all students, so that they know a fixed number of trials is needed, there are only two possible outcomes per trial and the outcome of each trial is independent.

Once the binomial distribution has been introduced link back to thinking about probability being the area under a curve. Use a bar chart for discrete binomial distributions and show how this would smooth into a curve if it were a continuous distribution. Another teaching point for this concept of area could come from considering the discrete uniform distribution as bars of equal width; it looks like a rectangle, like the continuous uniform distribution.

Students need to calculate probabilities using the binomial distribution for both individual and cumulative probabilities. Calculator use is expected for all of this, so time needs to be spent making sure students are competent in the use of these calculator functions.

The bar chart model mentioned earlier helps students distinguish between for example $\mathrm{P}(X < 2)$ and $\mathrm{P}(X \leq 2)$, also to understand $\mathrm{P}(X \geq 6) = 1 - \mathrm{P}(X \leq 5)$. Explain this is due to the binomial being a discrete distribution. This is essential when manipulating before using the calculator to find probabilities. Encourage students to shade the bars required to help with this understanding.

Emphasise the importance of reading questions carefully. The probability of success can be worded negatively in the question for example 'the probability of people failing their driving test first time is 0.6'.

Students are not expected to be able to calculate the mean and variance of discrete random variables.

OPPORTUNITIES FOR PROBLEM SOLVING/MODELLING

Look at a wide variety of real-world scenarios and model using a number of different distributions to ensure students are fluent in their comments on the appropriateness of a particular distribution.

COMMON MISCONCEPTIONS/EXAMINER REPORT QUOTES

The most common difficulty is with manipulating inequalities: 'A significant number of students were unable to cope with the expression $P(5 \le X < 11)$. There were students who translated this expression into the more convenient form $P(5 \le X \le 10)$ and then in turn transformed this into an equivalent form that can be applied to the table of cumulative probabilities: $P(X \le 10) - P(X \le 4)$. However, there were also many instances of incorrect versions such as: $P(X < 11) - P(X \ge 5)$, $P(X \le 10) + P(X \ge 5)$, $P(X \le 10) - (1 - P(X \ge 5))$ and $P(X \le 11) -$ either $P(X \le 5)$ or $P(X \le 4)$.'

In a similar vein, students have a tendency to write, for example, $P(X > 2)$ as $1 - P(X \le 1)$ instead of $1 - P(X \le 2)$.

NOTES

It would be good for understanding to see what the random variable looks like in pdf form and table form although this is not explicitly in the specification.