THE ACADEMY OF ST NICHOLAS	Y12 Applied	CH06 4.1	Statistics – Statistical Distributions	Lessons 5

Essential Knowledge Milestones

- Understand and use simple discrete probability distributions including the discrete uniform distribution
- Understand the binomial distribution as a model and comment on appropriateness
- Calculate individual probabilities from the binomial distribution
- Calculate cumulative probabilities from the binomial distribution

Success Criteria

- ❑ You can understand and use the notation of discrete random variables
- ❑ You can write a probability distribution as a probability mass function or in a table or diagram
- ❑ Given a probability distribution you are able to find the value of an unknown 'k' and hence find the associated probabilities
- ❑ You can use inequalities to calculate the probability of a number of events occurring
- ❑ You can define the 4 criteria needed to be able to use the binomial distribution
- ❑ You can calculate the outcomes of events using the binomial distribution on your calculator or using tables
- ❑ You can calculate the outcomes of cumulative events using the binomial distribution on your calculator or using tables

Assumed Prior Knowledge/ Links / Interleaving

GCSE (9-1) in Mathematics at Higher Tier

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

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.

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.
- Exploring the nature of DRV's is important as is the language. Students must know the subtle differences between tables and probability mass functions.
- Ex6AQ12 is an excellent segue into the world of binomial distributions. Some students will relish the challenge of the question and may begin with a tree diagram but then quickly move to considering combinations and permutations as they realise the size of the problem!
- 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.
- I like introducing it through the tree diagram method modelling a dice being rolled. I will ask questions like what is the probability of getting no 4's, one 4 etc… Students will start to see the symmetry in their solutions and also the structure of the formula. Especially if you write solutions in a column on the board. They will start to predict and realise how it works, if only they could find a way of quickly finding this multiplier at the front! Introduce nCr.
- They will happily work through questions using the formula until they start to find it's a bit more effort when dealing with cumulative probabilities. I then introduce the calculator which comes as a relief!!! They will enjoy checking their previous answers found the long way on their calculators.
- Call me old fashioned but I do like students to practice using the formula so that when they use their calculator they understand where the values come from rather than being blind.
- 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.
- I have a sheet that covers all the notation and the 4 assumptions. They must remember these!
- 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 P(X < 2) and P(X ≤ 2), also to understand P(X ≥ 6) = 1 - P(X ≤ 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. • I also draw number lines which I then put numbers around to support the transposition of questions into the required format. • A huge amount of time will need to be spent on transposing questions. There is a quick fire sheet that I have created to do this. • Ex6CQ7&8 are interesting – do not miss them out! • 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.
Potential Barriers to Access /Misconceptions	**Opportunities for Reasoning/Problem Solving/Proofs**
• Some student's will find the concept of a DRV difficult so help them be modelling situations. I tend to suggest imagining every situation as a spinner. • Some students will find the comprehension of a larger, worded context question difficult in terms of puling the right information to use. Try modelling a structure to question responses to help. • The most common difficulty is with manipulating inequalities: 'A significant number of students were unable to cope with the expression $P(5 \leq X < 11)$. There were students who translated this expression into the more convenient form $P(5 \leq X \leq 10)$ and then in turn transformed this into an equivalent form that can be applied to the table of cumulative probabilities: $P(X \leq 10) - P(X \leq 4)$. However, there were also many instances of incorrect versions such as: $P(X < 11) – P(X \geq 5)$, $P(X \leq 10) + P(X \geq 5)$, $P(X \leq 10) – (1 - P(X \geq 5))$ and $P(X \leq 11)$ – either $P(X \leq 5)$ or $P(X \leq 4)$. • In a similar vein, students have a tendency to write, for example, $P(X > 2)$ as $1 – P(X \leq 1)$ instead of $1 – P(X \leq 2)$.	• 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.
Key Mathematical Vocabulary	Binomial, probability, discrete distribution, discrete random variable, uniform, cumulative probabilities.

Personal Development	**Notes**	**Resources**
Pupils are taught that they must 'respect' each other's opinions and well-being when working collectively in class. Pupils to learn that mathematicians have 'ambition' to push boundaries when aiming to solve new problems **Resilience** – never giving up! Building confidence across the problem solving aspects of the course. **Ambition** – living life to the full – fulfilling dreams and aspirations – linking to future career and ambition plans. **Respect** – respect for others – the 9 protected characteristics **Personal Best** – First Work – Best Work every time		• DRV competition sheet • Tree diagram Binomial support • Binomial notation sheet • Quick Fire calculator/table check sheet • Additional context questions