THE ACADEMY OF ST NICHOLAS	Y12 Applied	CH07 5.1, 5.2	Statistics – Hypothesis Testing	Lessons 5

Essential Knowledge Milestones

- Understand the language and concepts of hypothesis testing
- Understand that a sample is used to make an inference about a population
- Find critical values of a binomial distribution using tables
- Carry out a one-tailed test for the proportion of the binomial distribution and interpret the results
- Carry out a two-tailed test for the proportion of the binomial distribution and interpret the results

Success Criteria

- ❑ You can set up a hypothesis test understanding the population parameter, test statistic, null hypothesis and alternative hypothesis and the significance level
- ❑ You understand the difference between a one-tailed test and a two-tailed test and are able to know which to use is any situation
- ❑ You can find a critical value and region for a probability distribution and know that if a test statistic falls in this range then the null hypothesis is rejected
- ❑ You can calculate the actual significance level and understand what it means
- ❑ You can carry out a one-tailed test in full (picking the most efficient method) and interpret your findings
- ❑ You can carry out a two-tailed test in full (picking the most efficient method) and interpret your findings

Assumed Prior Knowledge/ Links / Interleaving

- Please note that this is the first unit of work in Statistics which has no assumed prior knowledge from GCSE. In that sense this is brand new material!
- An understanding of how to calculate binomial probabilities and using samples from populations from previous units.

Teaching Points

- The concept of a hypothesis could be introduced initially by posing some hypotheses yourself. You may wish to make reference to the large data set again and say for example 'the daily maximum temperature was higher in Hurn than Heathrow in May 1987'. I often use a political scenario too. Eg. 28% of Americans voted for Trump, if we took a sample now what percentage would convince you that there has been a change in his popularity.
- Following this introduce the null and alternative hypotheses and their respective notation H0 and H1. Discuss how to move from statements like the one above to using the language of the binomial distribution in terms of looking at p, the probability of success. It's really important to outline how heavily this relies on good knowledge of the Binomial distribution from the very start.
- The focus of this sub-unit is the language used in terms of hypothesis testing, but a scenario must be set. You may wish to use an example like 'the number of 6s thrown in 50 throws of a dice', students could carry out this experiment and you could use their results to form a variety of tests which would cover all of the terminology without actually carrying out the tests. Make sure you save these examples to be tested in the next sub-unit.
- All of the terms from the keywords section should be thoroughly discussed and understood before attempting to carry out a hypothesis test. Whenever you read (or get students to read) questions aloud ask them what is the test statistic? Etc…
- The expected value of the binomial distribution being np needs to be appreciated for a two-tailed test. Again, this can be modelled easily by saying something like I roll a dice 60 times how many 4's should I expect.
- Once all the terminology has been discussed and is fully understood, you can go back to the examples you used and conduct the hypothesis tests. Carry out the tests both by finding the critical value to compare with your test statistic and by finding the probability (p-value) of the test statistic and comparing it with the critical region. Ensure students are competent with both methods. Make sure hypotheses are always written clearly in terms of p, the probability of success.
- Spend time making sure that students can write clear and concise conclusions in the given context of the questions. Model out a solution and expect students to follow it. Mentioning the significance level in the conclusion is important. Help them to understand that the conclusion could be very different if the significance level changed.
- When using a sample of data, ensure students understand, what it infers about the population itself.
- Type I errors are not part of the specification, but it is important that students understand what the significance level of a test actually means. Discuss carefully that rejecting the null hypothesis may actually be incorrect and the significance level is the probability of this. Also cover 'the actual significance level of a test' with students.

Potential Barriers to Access /Misconceptions	Opportunities for Reasoning/Problem Solving/Proofs
• Emphasise the importance of stating hypotheses clearly using the correct notation. Offer a model structure for students to follow. • Similarly, correct notation is important when describing the critical region: 'There were still a few students using incorrect notation for critical regions: $P(X \leq 1)$, for example, is not a critical region: it is a probability.' • Students will find calculating the critical values/region difficult. Particularly at the positive tail. Ensure they get lots of practice of the manipulation. • Context questions where students have to find the appropriate information are tricky. I.e. 5 things are tested every day of the week means 35 trials. • The most common error in these sorts of questions include not writing a clear conclusion in the context of the question. Students either omit the context or sometimes fail to give any conclusion to their calculations.	• Use a wide variety of scenarios from the real world and invite students to offer their own scenarios; discuss their suitability for hypothesis testing. There are many excellent real life scenarios to explore. • The textbook offers a number of problem solving questions for this unit.

Key Mathematical Vocabulary	Hypotheses, significance level, one-tailed test, two-tailed test, test statistic, null hypothesis, alternative hypothesis, critical value, critical region, acceptance region, p-value, binomial model, accept, reject, sample, inference.

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		• Random calculator spreadsheets can help you to see how samples can vary