PDST
Professional Development Service for Teachers | An tSeirbhís um Fhorbairt Ghairmiúil do Mhúinteoirí

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Department of Education

Inferential Statistics

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Overview of Seminar

Session 1	Welcome & Introduction Visual representation of z-scores
Break	
Session 2	Understanding Sampling Variability Confidence Intervals
Lunch	
Session 3	Hypothesis Testing Reflection & Conclusion

Introduction

Key Messages

Using a **constructivist approach** and building on prior knowledge when exploring statistics is important for students to make sense of mathematical concepts.

Multiple representations of mathematical concepts provide greater opportunity for students to develop deep conceptual understanding.

Applying Mathematics to **real life contexts** will demonstrate to students the usefulness and the power of Inferential Statistics.

By the end of this seminar, participants will:

- Have a clear understanding of the key messages for this workshop and understand how the workshop aligns with senior cycle key skills.
- Understand the importance of using **real world data** so that students will see the power and the need for statistics.
- Understand the importance of using **visual representations** as a tool to help to interpret and analyse data.
- Understand the importance of **reflecting** on their practice, the value of effective collaboration and the long term benefits of engaging with continual professional development.

What is Inferential Statistics?

- Students should get into the habit of showing supporting work at all times. This will help them tackle more difficult problems, and will allow them to check back for mistakes in their work.
- Students should develop strategies for checking their answers. In addition to techniques for identifying that an error has been made, techniques for finding those errors quickly and calmly, including getting to know one's own weaknesses, should also be developed.

Paper 2					
Section	Q	Mean Mark	Mean Mark (%)	Mark Ranking (Paper)	Main Topic
A	1	21·6	84	1	Probability
A	2	14·8	59	6	Inferential statistics
A	3	17·5	70	3	Co-ordinate geometry - line
A	4	18·6	75	2	Co-ordinate geometry - circle
A	5	14·2	57	7	Trigonometry
A	6	16·0	64	4	Geometry
B	7	22·8	57	8	Geometry/area
B	8	35·3	54	9	Probability
B	9	28.8	64	5	Trigonometry

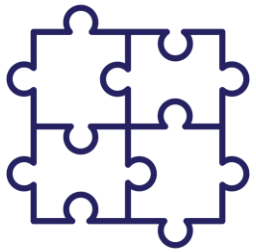
Table 15: Question level data including mean mark per question, Higher level Mathematics 2015.

Students should get used to describing, explaining, justifying, giving examples, etc. These are skills that are worth practising, as they will improve understanding, as well as being skills that may be directly assessed in the examination. Students do not need to be able to reproduce learned off statements of results or definitions, but they do need to be able to state or explain these reasonably clearly.

centres, the majority of the candidates seemed to be unfamiliar with this material. Another cause for concern was that, at Ordinary level, the concepts of margin of error, the creation of 95% confidence intervals, the use of the Empirical Rule, and understanding of standard deviation, were poorly dealt with. It may be anticipated that, as familiarity with these topics increases, the outcomes in relation to them in future years will improve at both levels.

Teachers should provide students with opportunities to practise solving problems involving real-life applications of mathematics, and to get used to dealing with "messy data" in such problems. Students should also be encouraged to construct algebraic expressions or equations to model these situations, and / or to draw diagrams to represent them.

Principles of Constructivism



The learner constructs his or her own knowledge and understanding

Learning does not occur when the learner passively receives information

Learners are the makers of meaning and knowledge, not simply the receivers

Psychology for the Classroom: Constructivism and Social Learning page 52

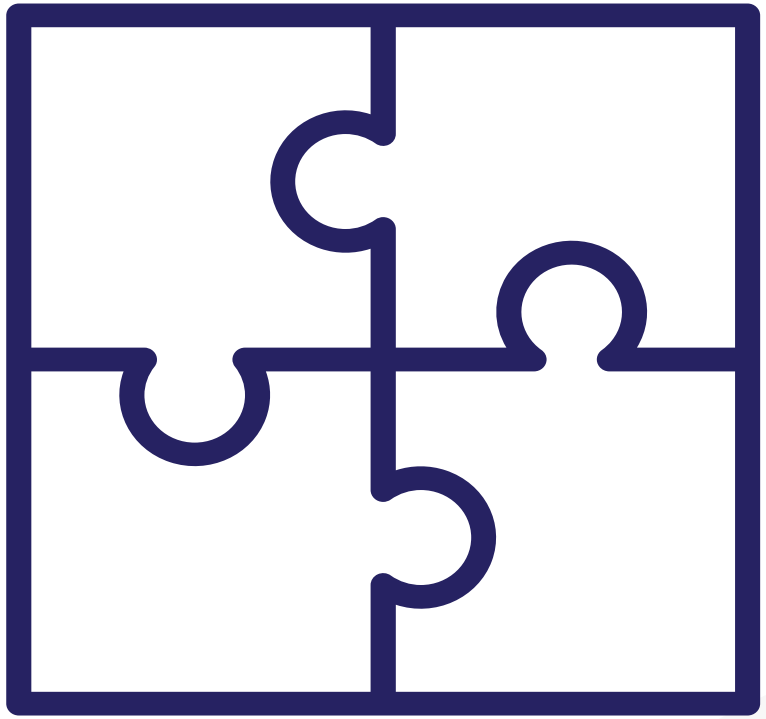
Resources

Padlet of resources:
https://padlet.com/postprimarymaths/odxuyqc59t9u3sel

Session 1

What is inferential statistics?

Discuss with your neighbour what is meant by this term.
Why would students need to know this?



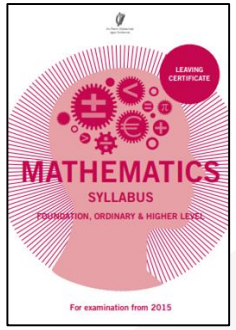
Normal Distribution

Prior Content Knowledge

- select appropriate methods to represent and describe the sample
- use a variety of summary statistics to describe the data:
  - central tendency (mean, median, mode)
  - variability (range)

- recognise standard deviation and interquartile range as measures of variability
- make decisions based on the empirical rule

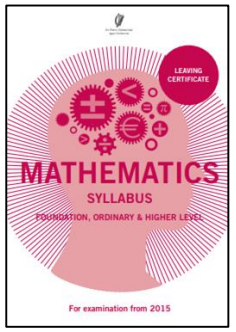
Leaving Certificate Syllabus pages 18 and 19



Normal Distribution

Key Content for this task

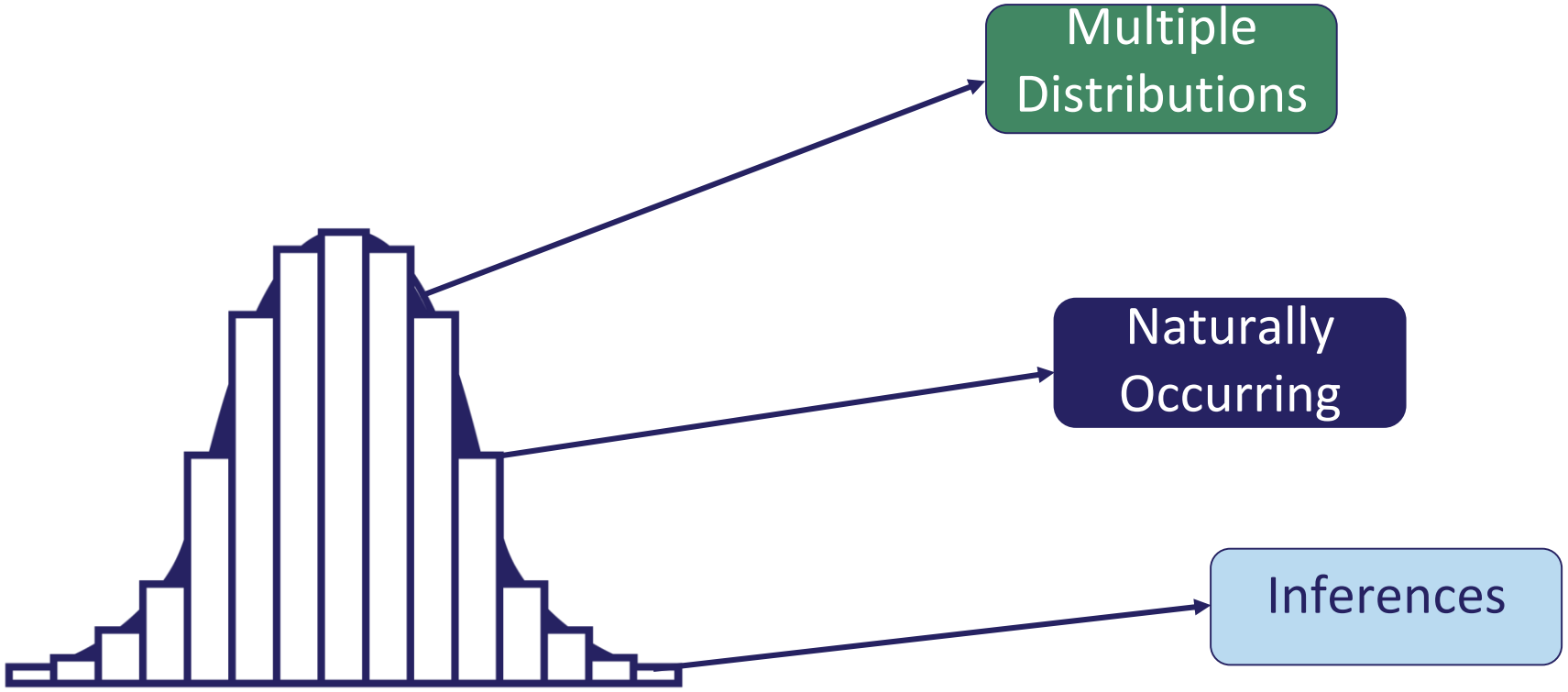
- construct 95% confidence intervals for the population mean from a large sample and for the population proportion, in both cases **using z tables**



Leaving Certificate Syllabus page 19

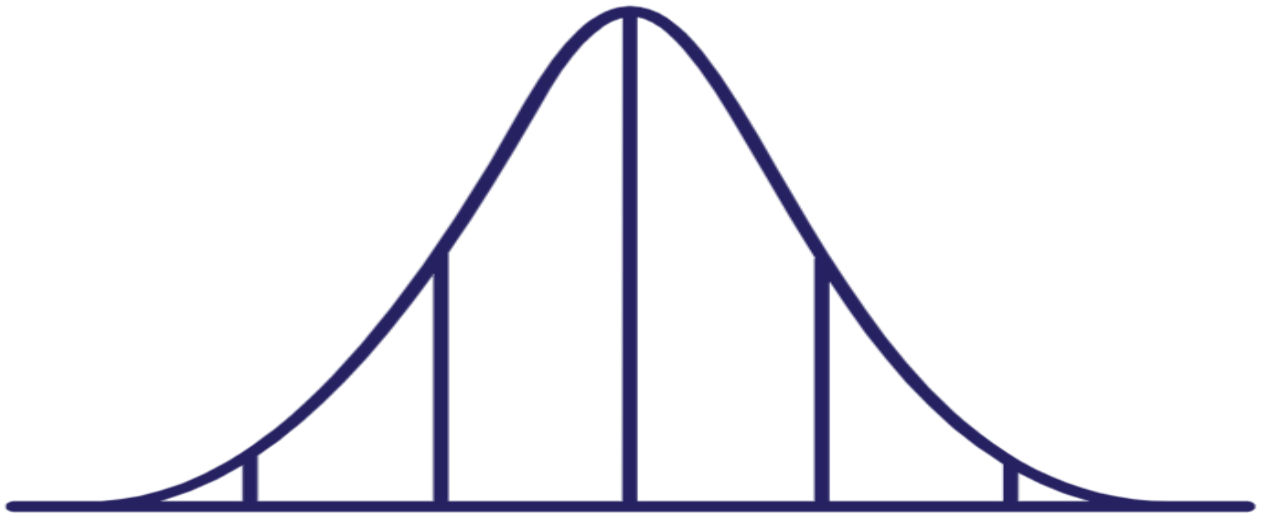
Pedagogy	**Methodologies**
Constructivism	Effective Questioning
	Visual representations

Power of Normal



Activity 1 - Prior Knowledge

Individual



Activity 2 - Exploring context

Pair

In a school all First years sat a common maths exam. The results, in integer values, were normally distributed with a mean of 176 marks and a standard deviation of 36 marks.

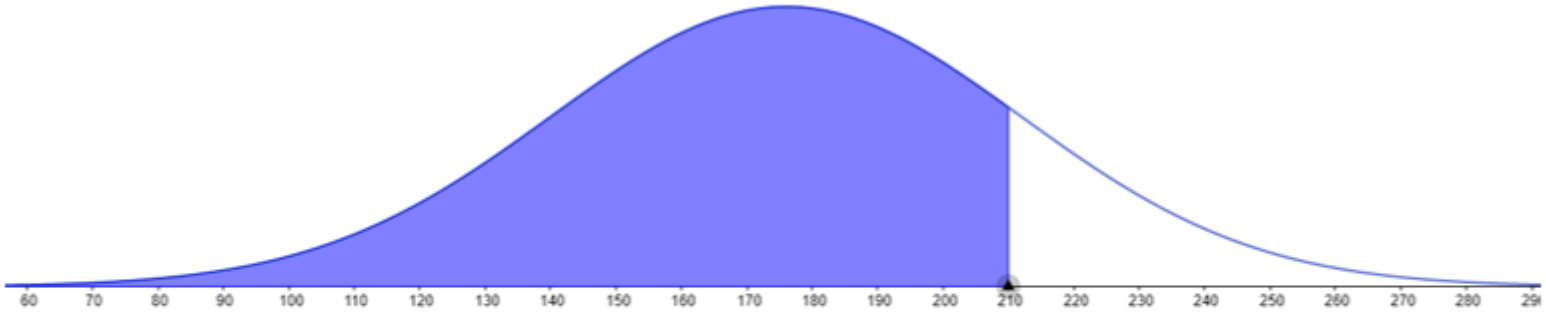
Estimate and calculate the probability that a student chosen at random scored 200 marks or less

Activity 3- Matching Activity

Group

The school awarded a *Certificate of Merit* to any student who achieved between 165 marks and 210 marks.

Estimate the percentage of First Years who received the *Certificate of Merit*

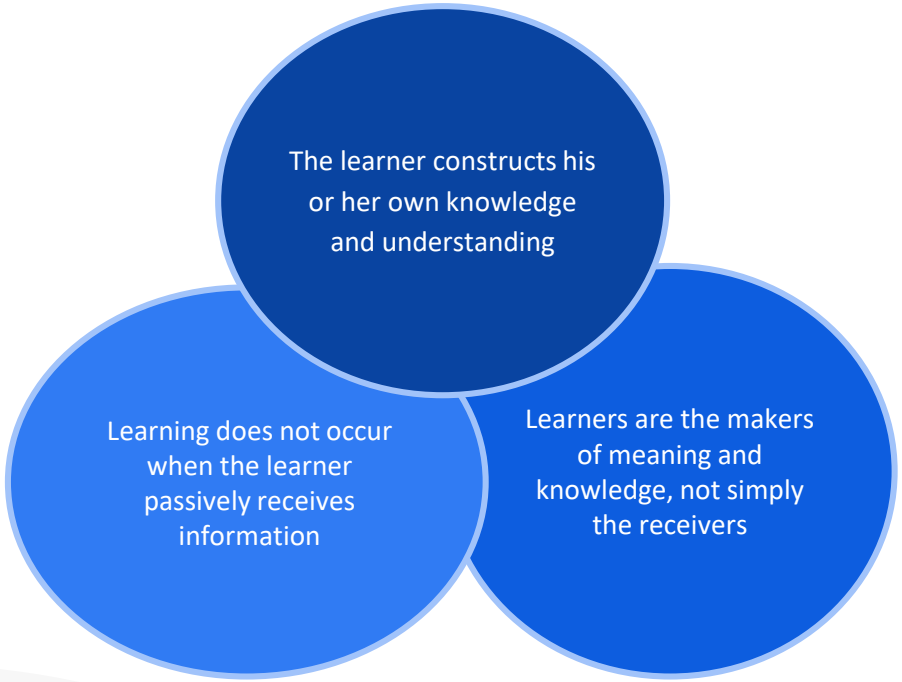


$P(X \leq 210)$

82.75%

Reflection

Could you highlight evidence of the principles of constructivism in the three activities?



Session 2

Margin of Error and Confidence Intervals

Key Content for this task

- construct 95% confidence intervals for the population mean from a large sample and for the population proportion, in both cases using z tables

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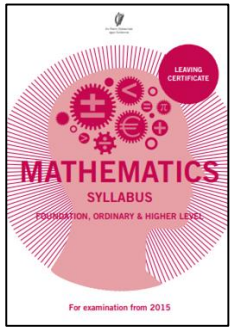


Pedagogy

Constructivism

Methodologies

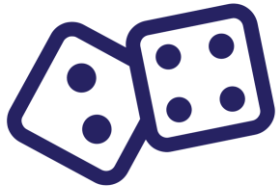
Effective Questioning

Group Work

Pose a question

How long does it take a student to travel to school?

Data from nature/experiments

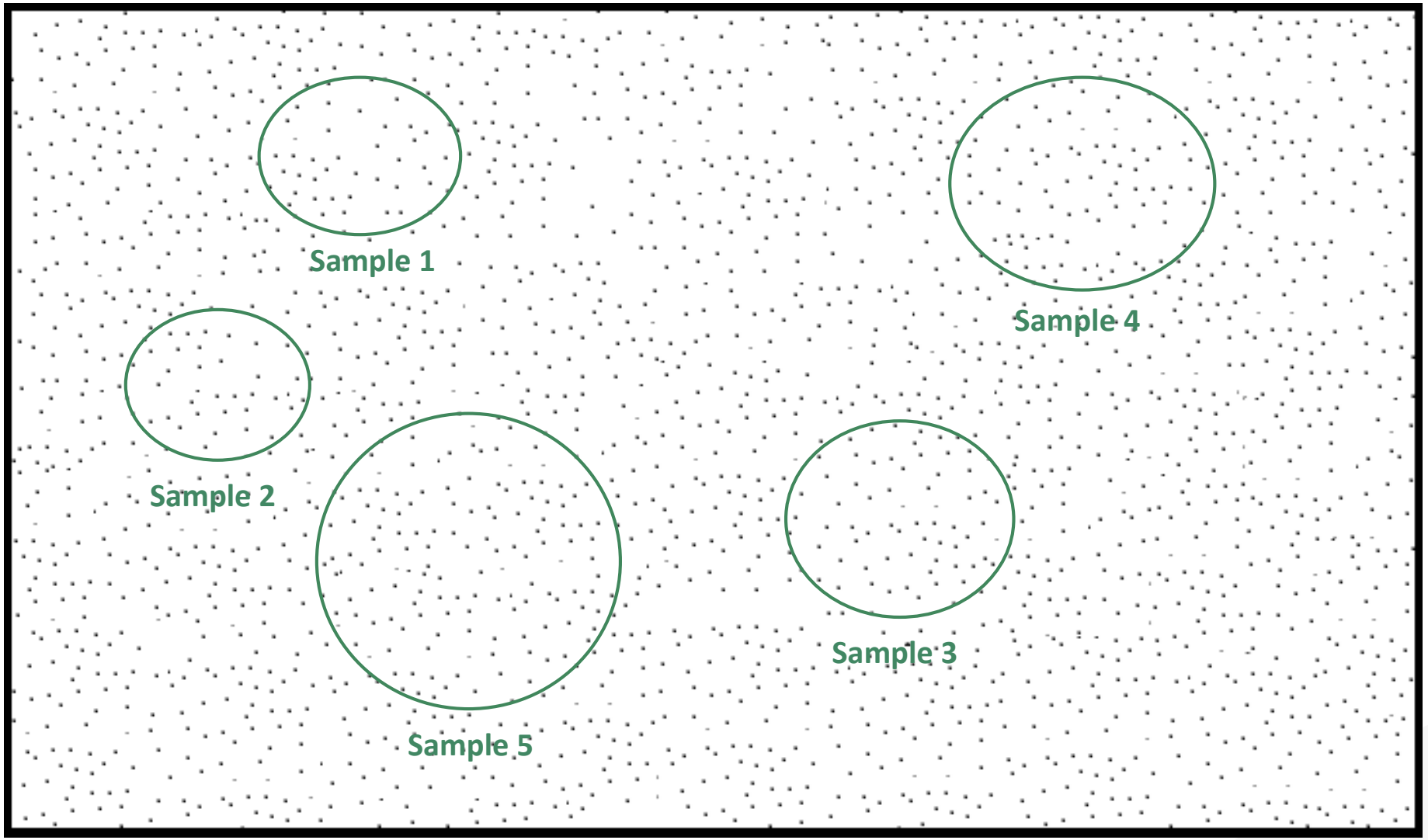


Data sets created to explore statistics

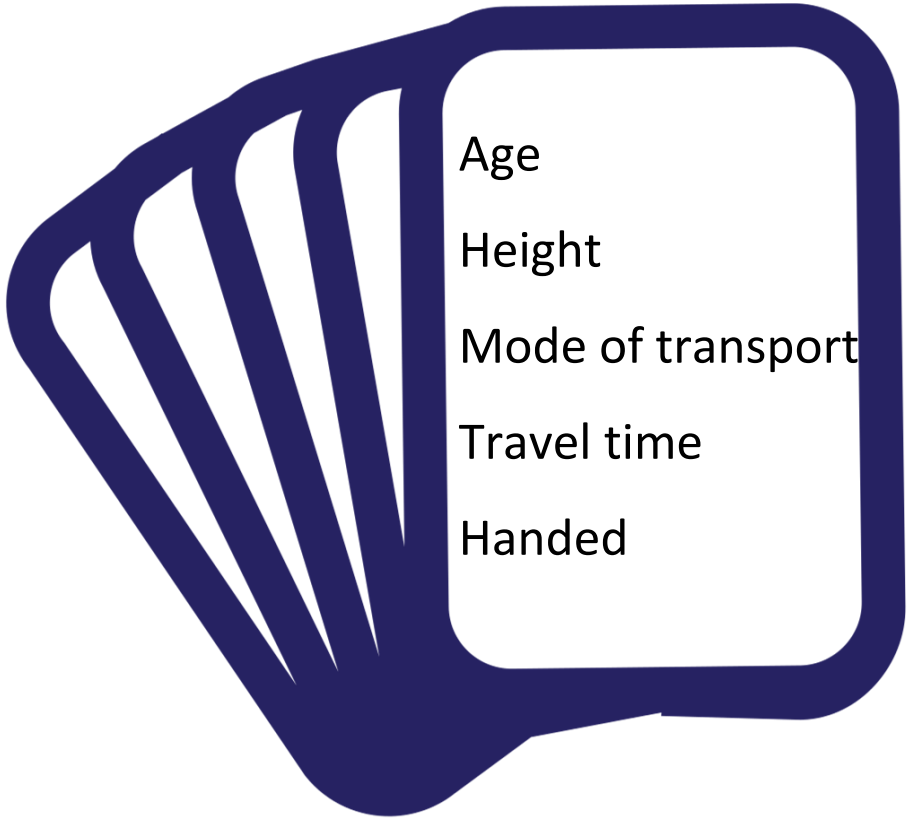
Data created by and used in text books

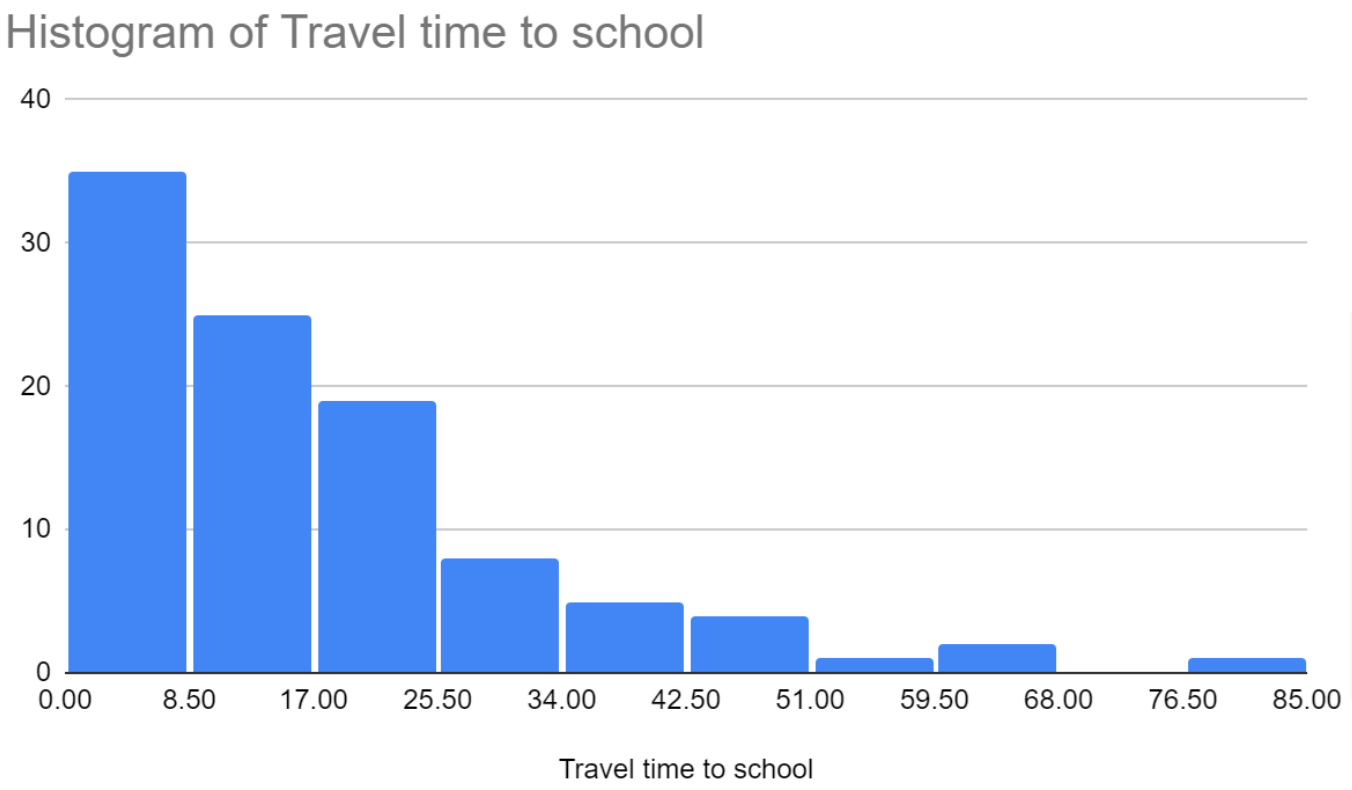
Census AtSchool

Sampling



Sampling variability

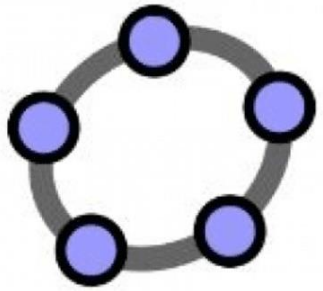


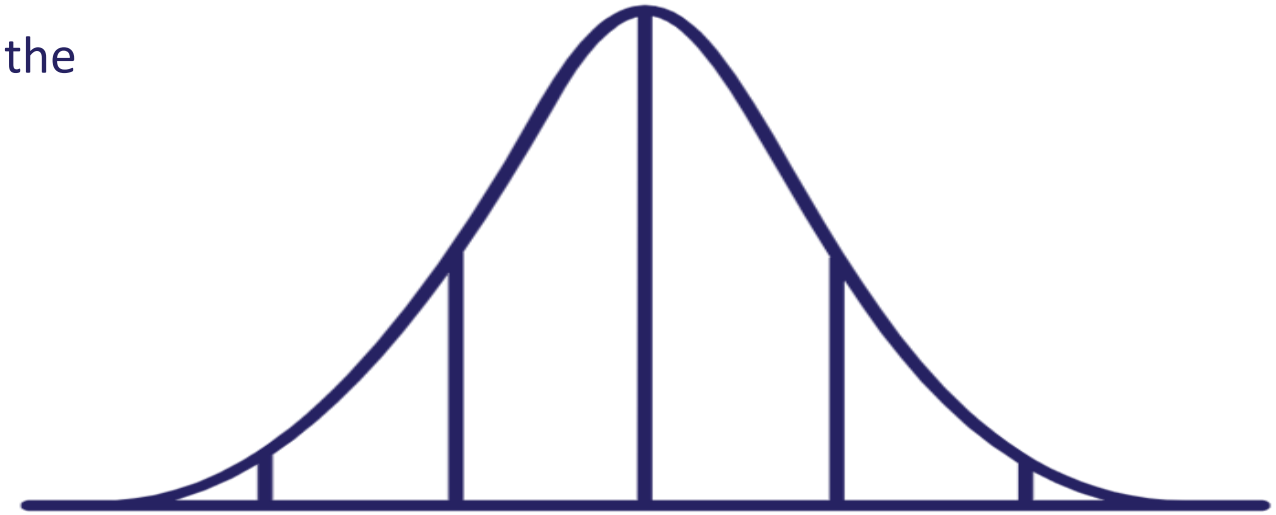


Discuss: How would this task benefit your students' understanding of Inferential Statistics?

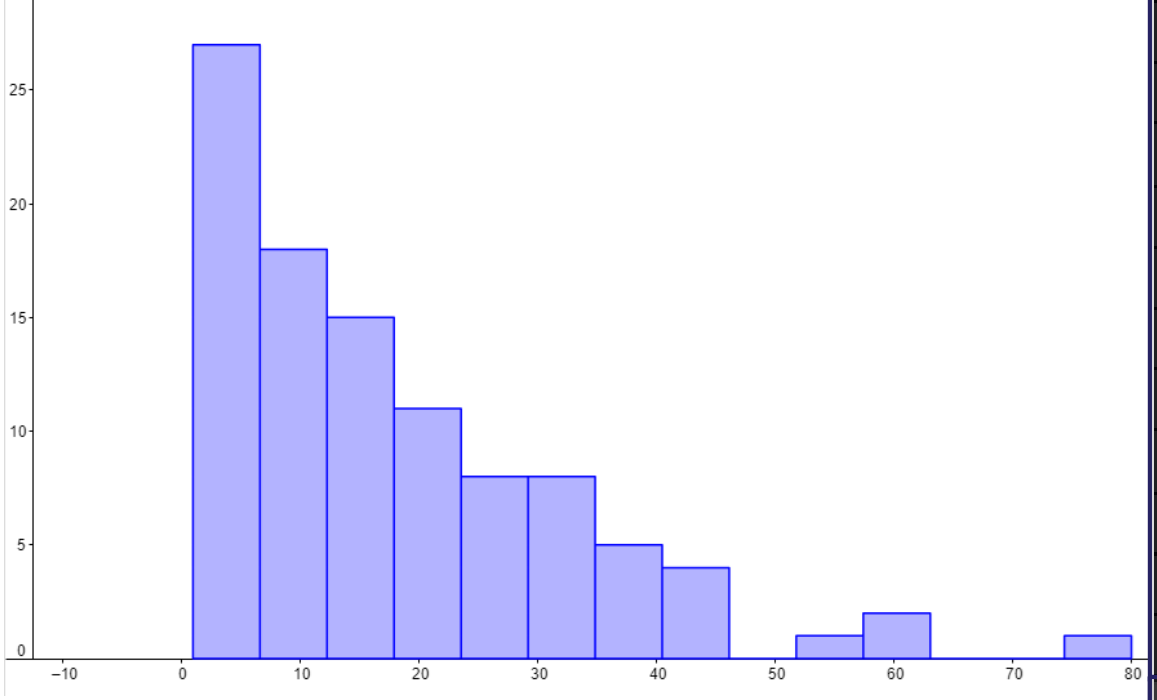
Confidence Intervals

Use your sample mean to infer the mean of the entire population.

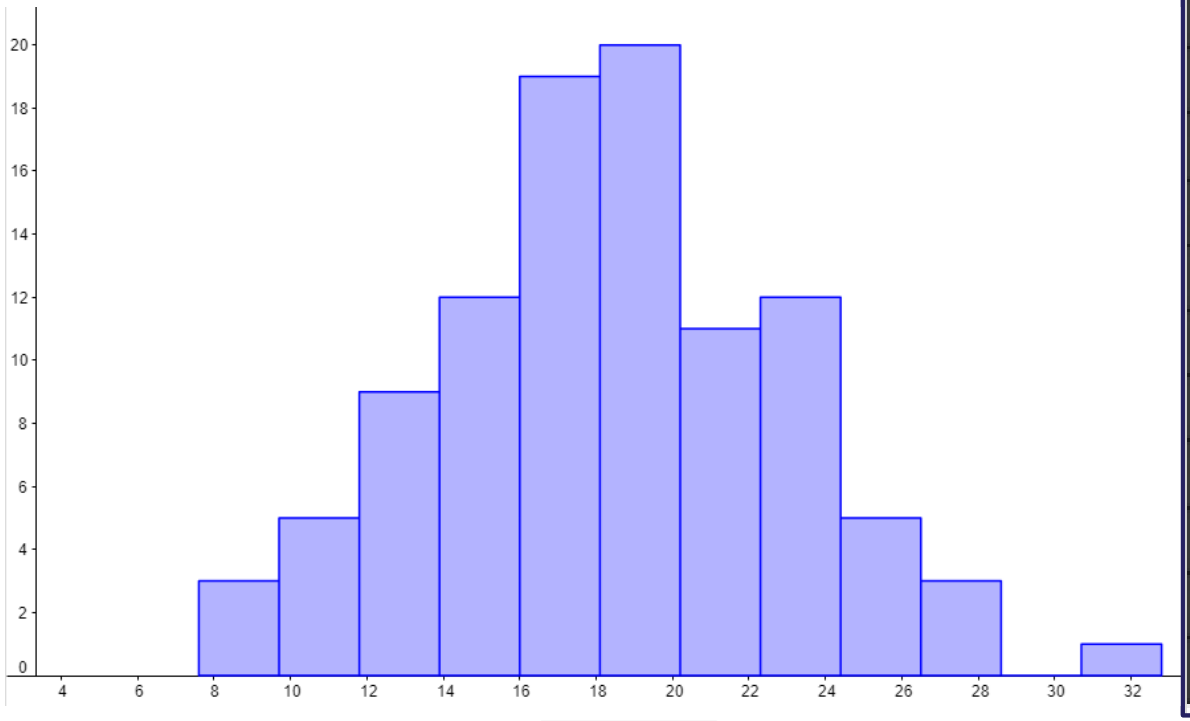




Summary



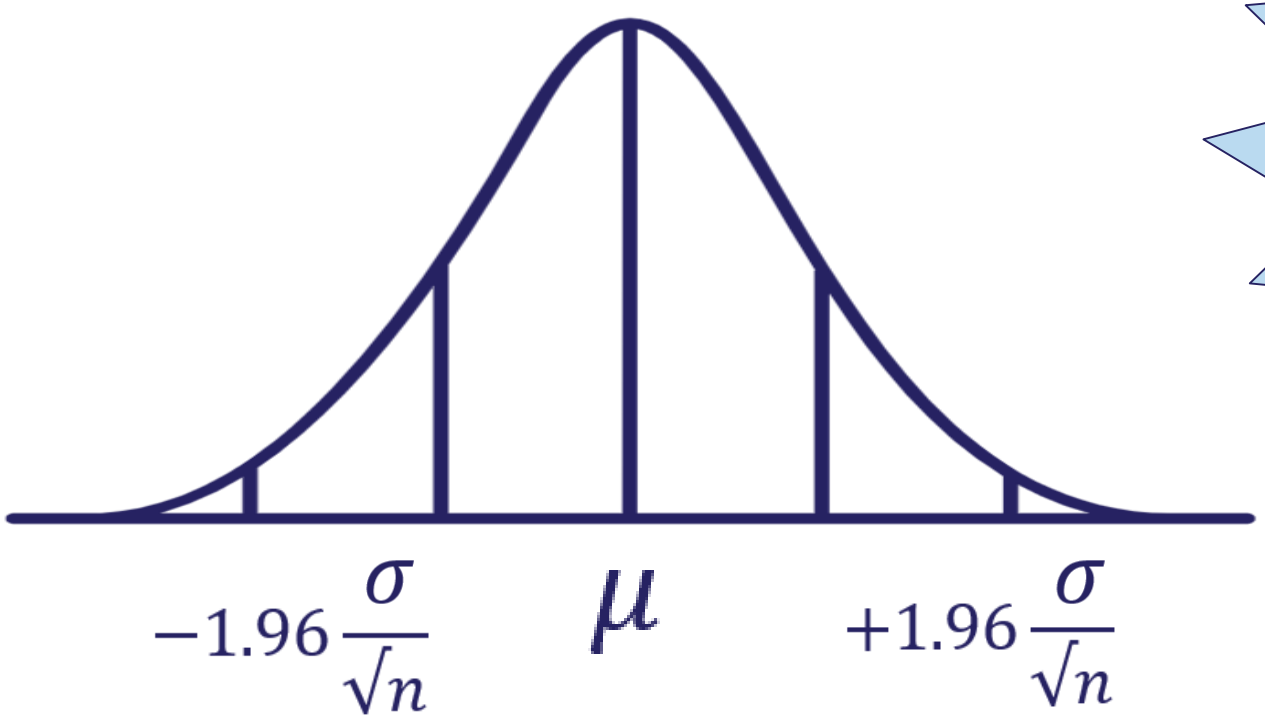
n	100
Mean	17.93
σ	14.7325
s	14.8067
Σx	1793
Σx²	53853
Min	1
Q1	6
Median	15
Q3	25
Max	80



n	100
Mean	18.289
σ	4.6319
s	4.6553
Σx	1828.9
Σx²	35594.23
Min	7.6
Q1	15.4
Median	18.55
Q3	21.45
Max	32.8

$$\frac{\sigma}{\sqrt{n}}$$

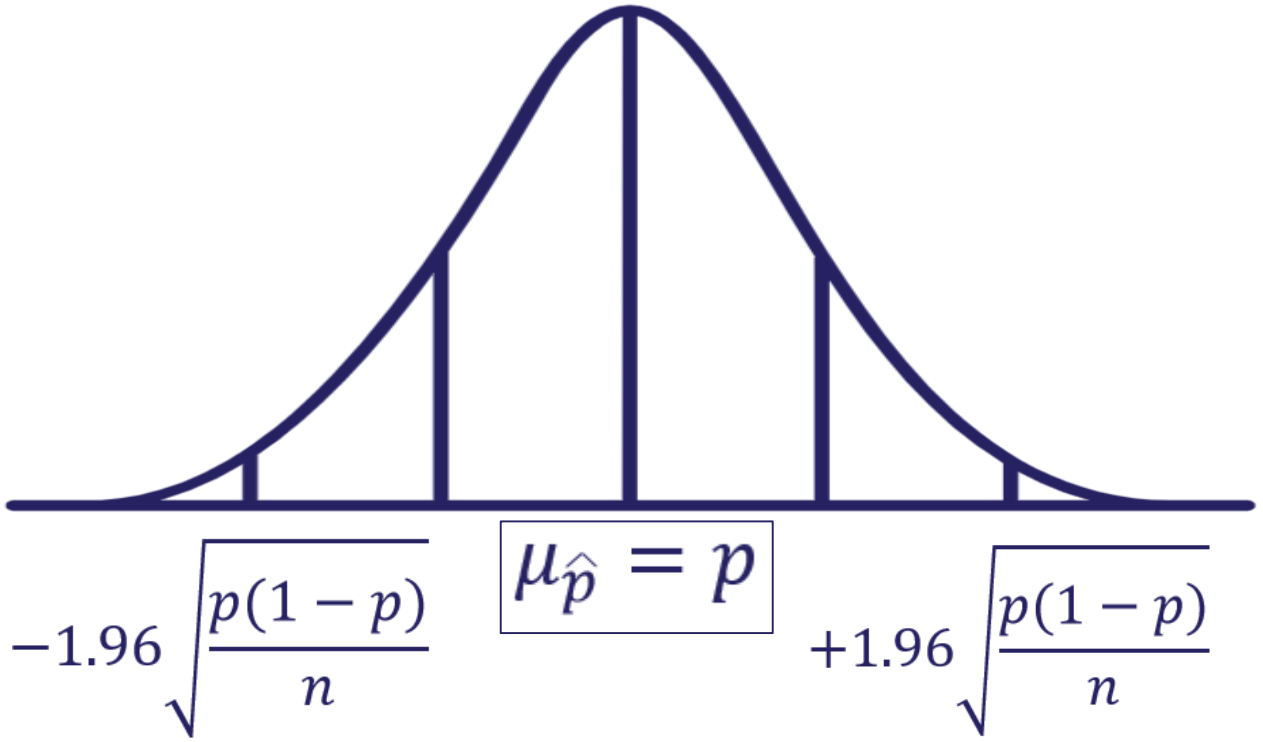
Distribution of sample means



Use of language

$$\mu = \mu_{\bar{x}}$$

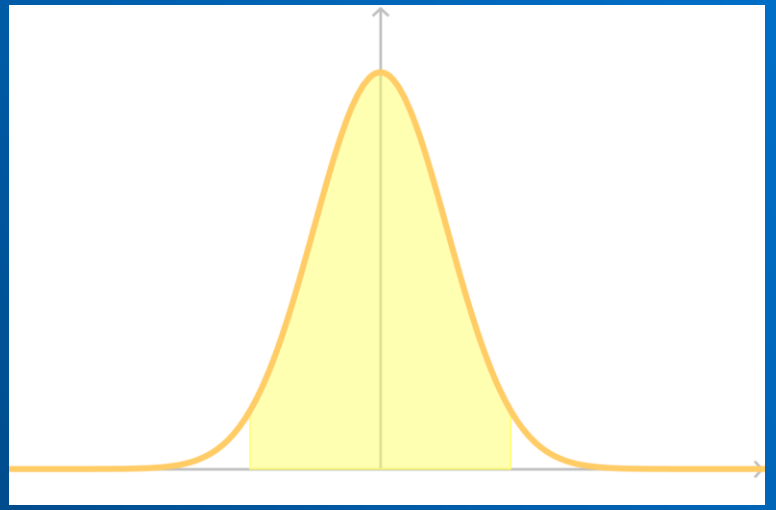
Distribution of sample proportions



Activity - Create a Poster

- Means

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

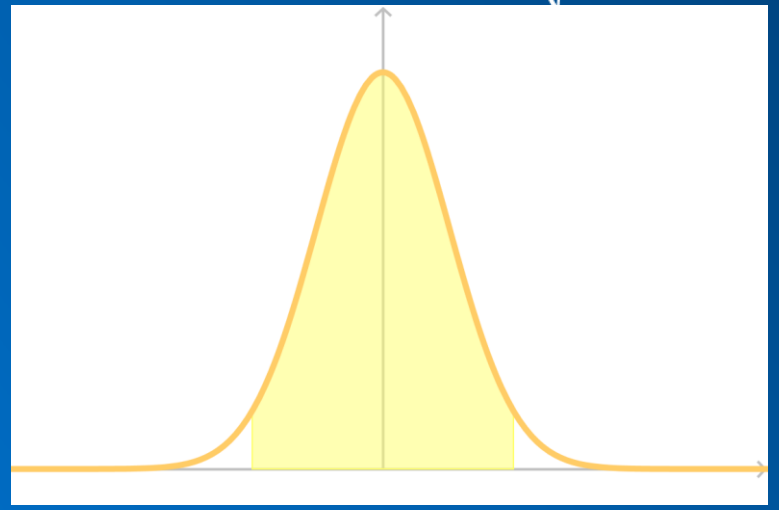


$$\mu_{\bar{x}} = \mu$$

I can say with 95% confidence that μ lies within $1.96\sigma_{\bar{x}}$ of my $\bar{x}$ value.

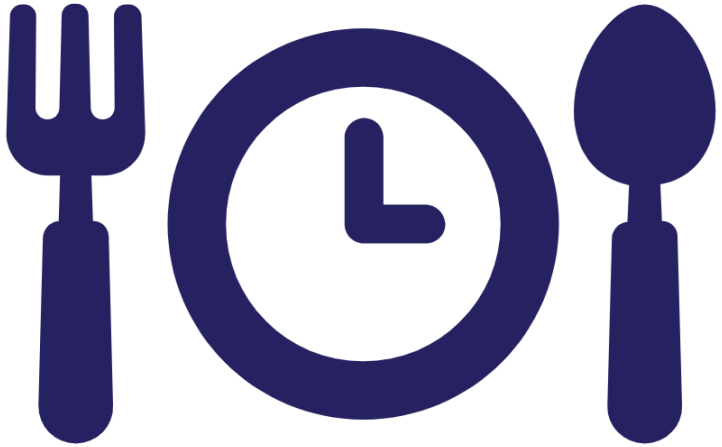
- Proportions

$$\sigma_{\hat{p}} = \sqrt{\frac{(p)(1-p)}{n}}$$



$$\mu_{\hat{p}} = p$$

I can say with 95% confidence that p lies within $1.96\sigma_{\hat{p}}$ of my $\hat{p}$ value.



Session 3

Sharing

Reflection

Reflect on the following and their impact on the workshop so far:

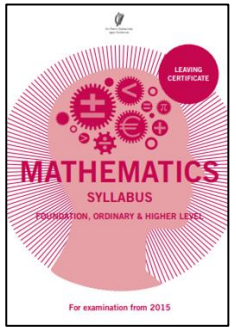
- Effective questioning
- Multiple representations

Hypothesis Testing

Key Content for this task

- recognise the concept of a hypothesis test
- conduct a hypothesis test on a population proportion using the margin of error

Leaving Certificate Syllabus page 19



Pedagogy

Constructivism

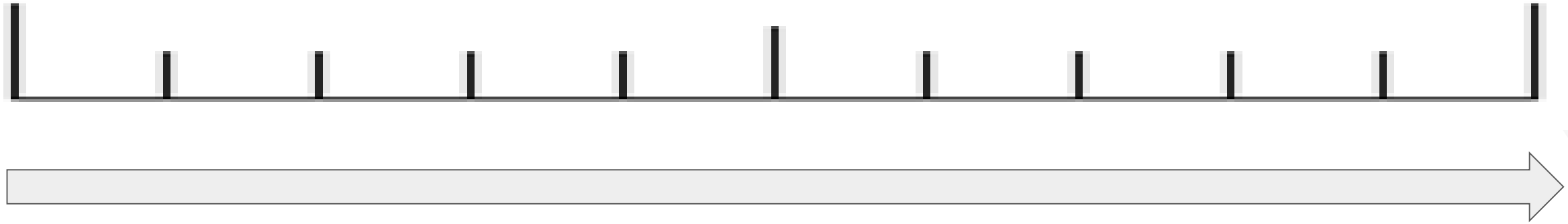
Methodologies

Discussion

Group Work

Activity - Language of Inferential Statistics

With your group discuss the meaning of the following terms and place them on the appropriate place on the scale.



Unsure

Certain

Activity - Language of Inferential Statistics part 2

Activity - Formatively assessing student work

Summary of criteria for Null and Alternative Hypothesis
Examples of Null Hypothesis and Alternative Hypothesis

Activity - Engaging with real life statistical claims

Using your knowledge gained from the previous exercise, conduct a hypothesis test on the statements provided.

Present your findings to your neighbouring group.

In Sept 2018, UK media outlets reported that unemployment had fallen by 55,000 from the previous month to 1,360,000. The UK National Statistics Office had conducted research using a sample size of 220,000. The population of employed persons was 32,400,000.

How does an understanding of statistics empower us as citizens?

Reflection

What are the benefits of this approach of engaging with statistics in the real world to students?

How would these approaches help students to make sense of hypothesis testing?

Conclusion

Reflection

What benefits are there for students when teaching Inferential Statistics using the constructivist approach?

What do you see as the challenges and opportunities of using multiple representations to teach Inferential Statistics?

How would using real life contexts when teaching Inferential Statistics benefit teachers/students?

Key Messages

Using a constructivist approach and building on prior knowledge when exploring statistics is important for students to make sense of mathematical concepts.

Multiple representations of Mathematical concepts provide greater opportunity for students to develop deep conceptual understanding.

Applying Mathematics to real life contexts will demonstrate to students the usefulness and the power of Inferential Statistics.

By the end of this seminar, participants will:

- Have a clear understanding of the key messages for this workshop and understand how the workshop aligns with key tenets of policy.
- Understand the importance of making connections with other topics in Mathematics and other cross-curricular links that will help students to make sense of Inferential Statistics.
- Understand the importance of using real world data so that students will see the power and the need for statistics.
- Understand the importance of using visual representations as a tool to help to interpret and analyse data.
- Understand the importance of reflecting on their practice, the value of effective collaboration and the long term benefits of engaging with continual professional development.

School Support

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Using GeoGebra to support teaching, learning and assessment

- Getting students started with GeoGebra.
- Effective use of GeoGebra in the classroom.
- Sample student activities.
- Design of rich tasks.

Exploring Mathematical Content

- Making connections across the strands.
- Common approaches to teaching key concepts and skills.
- Problem solving.
- Sample student activities.
- Design of rich tasks.

Planning for Transition Year

- Examining current practice.
- Sample student activities.
- Design of rich tasks.
- Planning for best practice in teaching, learning and assessment.
- The role of Maths in cross-curricular learning.
- The role of digital technologies in transition year.

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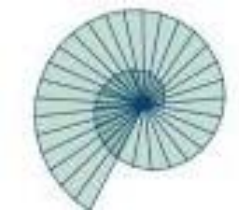
PDST Post-Primary Maths Team



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