

# Lesson Research Proposal for 2<sup>nd</sup> Year Statistics

Date of lesson: 04/03/2019

School name: St Brendan's College / St Brigid's Presentation Secondary School

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## 1. Title of the Lesson: Show Me The Money!

## 2. Brief description of the lesson

We have chosen real-life data in order to facilitate statistical analysis by students. The use of money and celebrity promotes discussion, allowing students to recognise the different measures of central tendency and to draw conclusions about their uses.

## 3. Research Theme

### Learner Outcome

- For pupils to enjoy their learning, be motivated to learn and expect to achieve as learners.
- We hope for them to have the necessary knowledge and skills to demonstrate their knowledge and to understand what is required by the curriculum.

### Learner Experiences

- We hope that students get a great sense of enjoyment out of the meaningful learning.
- We hope that students are challenged and support one another in their learning interactions.
- We will strive for students to reflect on their learning throughout.

### Teacher's Collaborative Practice

- We, as teachers, understand the importance of collaboration and engaging in professional development as a means to improving students learning.
- We hope that working together will help us to devise a learning opportunity for pupils that will go beyond the curriculum and meet the varying needs present in the classroom today.
- We, as teachers, hope to enhance the range of teaching methodologies that we can use in the day to day classroom.

## 4. Background & Rationale

We chose the topic of choosing the appropriate central tendency to use when looking at a set of data with a 2<sup>nd</sup> Year Mixed Ability class.

According to the Chief Examiner's Report, 2015, "In terms of content, the biggest change is an increase in the proportion of the syllabus dealing with statistics and probability. In terms of skills, the new syllabus has an increased emphasis on problem-solving, as well as on the skills of explanation, justification, and communication."

We have found that there are misunderstandings of averages. There are many colloquial words that are used for the idea of average, such as 'typical' or 'common' or even the word 'average' itself.

Activities where students collect their own data and compare the mean, the median and the mode can be useful in building intuitions for distinguishing the measures of central tendency.

Using the median meaningfully is perhaps the most difficult. Students can believe that it is possible to find the median of categorical data sets.

Activities that challenge students' thinking about mean, median, mode, and the difference between numerical and categorical data are needed.

When focussing on the mean, students at times forget outliers, especially if there is no accompanying graph to attract attention. Activities where outliers are included can be useful.

## 5. Relationship of the Unit to the Syllabus

Related prior learning Outcomes	Learning outcomes for this unit	Related later learning outcomes
<ul style="list-style-type: none"> <li>- Collect, organise and represent data using pictogram, single and multiple bar charts, pie charts and trend graphs</li> <li>- Read and interpret pictograms, single and multiple bar charts and pie charts</li> <li>- Compile and use simple data sets</li> <li>- Explore and calculate average of simple data sets</li> <li>- Identify the most frequently occurring item in a data set.</li> <li>- Compare calculate average with the most frequently occurring item</li> <li>- Students should be able to carry out a statistical investigation which includes the ability to: select, draw and interpret appropriate graphical displays of univariate data, including pie charts, bar charts, line</li> </ul>	<p>Students should be able to carry out a statistical investigation which includes the ability to:</p> <ul style="list-style-type: none"> <li>- select, calculate and interpret appropriate summary statistics to describe aspects of univariate data. Central tendency: mean (including of a grouped frequency distribution), median, mode. Variability: range (SP3E)</li> <li>- discuss misconceptions and misuses of statistics (SP3G)</li> </ul>	<ul style="list-style-type: none"> <li>- Students should be able to carry out a statistical investigation which includes the ability to:</li> <li>- select, draw and interpret ordered stem and leaf plots, and ordered back-to-back stem and leaf plots (SP3d)</li> <li>- evaluate the effectiveness of different graphical displays in representing data (SP3f)</li> </ul> <p>Leaving Cert</p> <ul style="list-style-type: none"> <li>- (F)Use a variety of summary statistics to describe the data: central tendency mean, median, mode</li> <li>-</li> <li>- (O)Find the quartiles and the interquartile range</li> <li>- Use the interquartile range appropriately when analyzing data</li> </ul>

plots, and histograms (equal intervals) (SP3d) - Classify data (categorical, numerical) (SP3c) - Calculating the mean, median and mode		- (H)Line of best fit - Recognise the effect of outliers
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## 6. Goals of the Unit

Unit of learning: Measures of Central Tendency

Students should be able to:

- Name the different measures of central tendency
- Calculate the different measure of central tendency
- Recognise when to use the appropriate measures of central tendency given different sets of data

## 7. Unit Plan

Lesson	Brief overview of lessons in unit
1	Types of Data
2	Calculate the mode, mean and median
3	Research Lesson - Applying the measures of central tendencies to real life problems and identifying which is the most appropriate to use in different data sets.
4	Identify an appropriate central tendency for a given graph

## 8. Goals of the Research Lesson:

Looking at the goals of the research lesson itself from two perspectives:

### a. Mathematical goals

By the end of the lesson students will -

know how to apply the measures of central tendencies to real life problems  
 understand which is the most appropriate to use in different data sets.

### b. Key Skills

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>- Using number</li> <li>- Performing and presenting</li> <li>- Discussing and Debating</li> <li>- Respecting difference</li> <li>- Learning with others</li> <li>- Exploring options and alternatives</li> <li>- Expressing ideas mathematically</li> <li>- Developing a positive disposition</li> </ul> | <ul style="list-style-type: none"> <li>towards investigating, reasoning and problem solving</li> <li>- Seeing patterns, trends and relationships</li> <li>- Being curious</li> <li>- Evaluating information and data</li> <li>- Reflecting and evaluating my learning</li> <li>- Being social</li> <li>- Being confident</li> </ul> |
|---|---|

### b. (ii) Statements of learning

The student should be able to:

- communicate effectively using a variety of means in a range of contexts.
- recognise the potential uses of mathematical knowledge, skills and understanding in all

- areas of learning
- describe, illustrate, interpret, predict and explain patterns and relationships
- devise and evaluate strategies for investigating and solving problems using mathematical knowledge, reasoning and skills

## 9. Flow of the Research Lesson:

Steps, Learning Activities Teacher's Questions and Expected Student Reactions	Teacher Support	Assessment
This column shows the major events and flow of the lesson, including timings and what will go up on the board.	This column shows additional moves, questions, or statements that the teacher may need to make to help students.	This column identifies (a) what the teacher will look for (formative assessment) that indicates it makes sense to continue with the lesson, and (b) what observers should look for to determine whether each segment of the lesson is having the intended effect.
<b>Introduction</b>  Roll call Recap on what was covered in previous lessons.		
<b>Posing the Task</b>  Working in pairs students must find the average age, average earnings and the "average" profession of The World's Highest – Paid Celebrities from the Forbes 2018 Ranking.	The question is read aloud.	Do all students understand the task?
<b>Student Work</b>  Using the worksheet, students calculate the mean, median and mode of each set of data.		Are pairs working together on individual tasks or are they dividing the work?  Which measure of central tendency are students using?  Are students finding more than one measure of central tendency?

Forbes  
The World's Highest Paid Celebrities 2018

Rank	Name	Age	Earnings	Profession
1.	 Floyd Mayweather	41	\$535 M	Athletes
2.	 George Clooney	57	\$189 M	Actors
3.	 Kylie Jenner	21	\$186.5 M	Personalities
4.	 Dwayne Johnson	46	\$126 M	Actors
5.	 Lionel Messi	31	\$111 M	Athletes
6.	 Ed Sheeran	27	\$111 M	Musicians
7.	 Cristiano Ronaldo	34	\$111 M	Athletes
8.	 Bruno Mars	34	\$100 M	Musicians
9.	 Canelo Alvarez	30	\$99 M	Athletes
10.	 Neymar	26	\$90 M	Athletes

Rank	Name	Age	Earnings	Profession
11.	 Ellen DeGeneres	50	\$87.5 M	Personalities
12.	 Liam James	34	\$85.5 M	Athletes
13.	 Katy Perry	34	\$83 M	Musicians
14.	 Robert Downey Jr.	43	\$81 M	Actors
15.	 Taylor Swift	29	\$80 M	Musicians
16.	 Roger Federer	37	\$79 M	Athletes
17.	 Stephen Curry	25	\$79 M	Athletes
18.	 Jay-Z	44	\$79 M	Musicians
19.	 Ryan Seacrest	40	\$79 M	Personalities
20.	 Kim Kardashian West	39	\$67 M	Personalities

Are students using the appropriate terms?

Can students calculate the mean?

Can students find the median?

Have students ordered the data?

Are students finding the mode of the third column?

### Ceardaíocht /Comparing and Discussing

Students present their work, explaining  
(a) how they calculated each measure of central tendency, and  
(b) why they would use this measure.

Why have they ordered the data?

What are the different types of data being used?

Why have they used the mean, mode or median? Is this the best? Why?

Did anyone find the mean profession?

Why is the result for the mean wage and median wage so different?

Why did students use neither mean nor median for the “profession” column?

Can students discuss and explain why they would or would not use a particular measure of central tendency?

Do students recognize when to use the appropriate measures of central tendency given different sets of data?

Are students using the correct terms for each measure of central tendency and each data type?

What are the misunderstandings students have?

Can students recognize the outlier?

Did some try to use mean or mode for the “profession” column?

### Summing up & Reflection

<p>Students -</p> <ul style="list-style-type: none"> <li>name the different measures of central tendencies</li> <li>explain how to calculate the different measure of central tendencies</li> <li>explain when to use the appropriate measures of central tendency given different sets of data</li> <li>fill in reflection sheet</li> </ul>	<p>What is the best job to have? Why? How do we know this?</p> <p>Which category of celebrities are the wealthiest people on the Forbes Celebrity Rich List?</p>	<p>Can students answer teacher's questions using mean, mode and median?</p>
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## 10. Board Plan

**Board Plan**

**Learning Intentions**  
"What & Why?"

In as many ways as possible find the average age, earnings and profession of the World's Highest Paid Celebrities

**Age**

**Mode**  
= 34 - FC

**Mean**  
$$\frac{41+57+71+46+31+37+34+34+30+16+30+34+36+43+19+37+33+36+46+38}{20} = 36.05$$
 SD

**Median**  
21, 25, 26, 27, 29, 30, 31, 34, 34, 34, 34, 37, 38, 40, 41, 43, 44, 46, 50, 57  
= 34  
L.C

**Wage**

**Mode**  
75 million - SL

**Mean** outlier  
$$\frac{335+189+166.5+124+111+111+111+100+99+90+87.5+85.5+83+81+80+75+75+75+75+67}{20} = \frac{2220.5}{20} = 111.03$$
 C.M

**Median**  
67, 75, 75, 75, 75, 80, 81, 83, 85.5, 87.5, 90, 99, 100, 111, 111, 111, 124, 166.5, 189, 335  
=  $\frac{87.5+90}{2} = 88.75m$  AV  
Outlier

**Profession**

**Mode**  
= Athlete CC

**Mean**

**Median**

**KEYWORD**

Categorical data  
Mode  
Numerical data  
Mode  
Outlier  
Mean  
Median

Do not use mean if we have an outlier

## 11. Evaluation

During the lesson the team had hoped to observe students producing a variety of suitable calculations to determine a measure of central tendency for given data sets. We had hoped that the students would actively participate in a discussion on, and thereby gain and understanding of, which would be the most appropriate measure of central tendency to use.

At the end of a lesson students will use "5-4-3-2-1", to feedback to the teacher.

In using this feedback mechanism, the teacher aims to

- focus the student's attention on the positive learning outcomes for them in the lesson
- have students identify an aspect on which they need to do some more learning.

## 12. Reflection

### What the team had hoped or expected to observe during the lesson.

The team hoped that the students would work together in their groups to find the average for each category. We expected the students would realize that there is more than one way to find the average, i.e. mean median and mode. We expected the students would divide the workload among the group, for example each member in the group take a category.

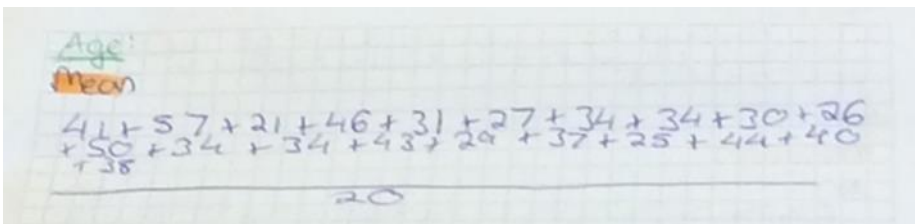
### What the team actually observed during the lesson by the team members

The team felt the lesson was clear and coherent. The students did not go off task, they stayed on topic. The lesson was student centred. The team felt that the students would remember the topic better than rote learning. The team felt working in pairs cleared up any questions they might have had. Without telling the students the meaning of the outlier, the effective use of questioning led the students to define the word outlier themselves.

The team observed various approaches to the task. In some groups, each member calculated a different average in a category, for example one student calculated the mean, another the median and the mode. The team noticed that these groups did not partake in discussion in their groups when compared to others. When one member had completed their task they did not help other members with theirs. Thus putting pressure on some in the group. Other groups worked together on each calculation, cross checking their answers. This proved quite effective. It promoted discussion amongst the group as to appropriate approach.

In terms of calculations the team observed a number of various methods. When finding the median, the majority of groups listed the data in order. One group used a stem and leaf to calculate the median. Some groups made use of colours and highlighters to organize the data when finding the mode profession. From the team observations, the majority of groups started by calculating the mean.

### Finding the Mean



Handwritten student work showing the calculation of the mean for a set of ages. The work is written on grid paper and includes the following steps:

Age:  
Mean

$$\begin{array}{r} 41 + 57 + 21 + 46 + 31 + 27 + 34 + 34 + 30 + 26 \\ + 50 + 34 + 34 + 43 + 29 + 37 + 25 + 44 + 40 \\ + 38 \\ \hline 20 \end{array}$$

Earning

mean  $(855 + 124 + 166.5 + 124 + 111 + 111 + 111 + 100 + 99 + 90 + 87.5 + 85.5 + 83 + 81 + 80 + 76 + 75 + 75 + 75 + 67) = 2135$

$\frac{2135}{20} = 106.75$

### Finding the Median

Practising

Average age:

stem	leaf
2	1 5 6 7 9
3	0 1 4 4 5 4 7 8
4	0 1 9 4 0
5	0 2

mean: 36.05  
 Median: 35  
 Mod: 35

21 25 26 27 29 30 31 34 34 34 34

37 38 40 41 43 44 46 50 57

$34 + 34 = 68 \div 2 = 34$

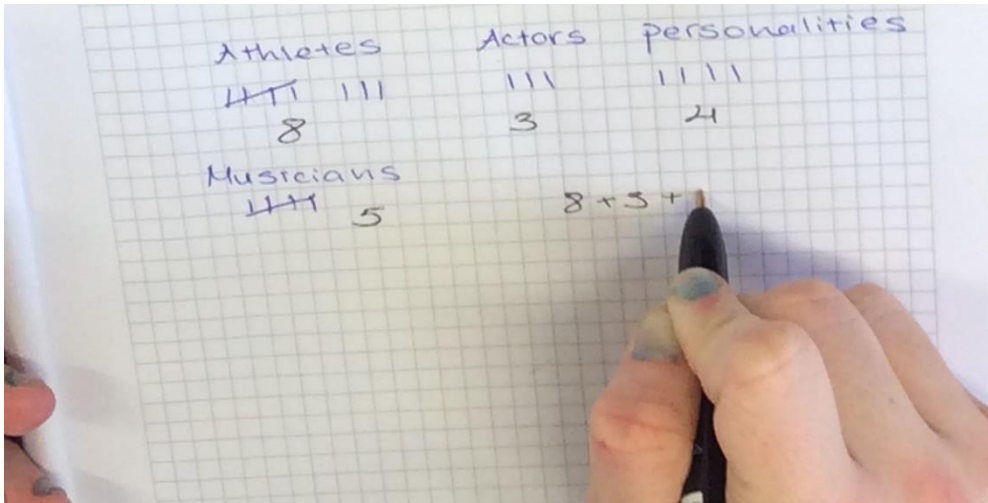
Earning

855, 124, 166.5, 124, 111, 111, 111, 100, 99, 90,  
 87.5, 85.5, 83, 81, 80, 75, 75, 75, 75, 67.

90, 87.5

### Finding the Mode





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Issues Addressed

$$\begin{array}{r} \text{Wage} - 335M + 189M + 166.5M + 124M + 111M + 111M + \\ 111M + 100M + 99M + 90M + 87.5M + 85.5M + \\ 83M + 81M + 80M + 75M + 75M + 75M + 75M + \\ 67M \\ \hline 20 \end{array}$$

Including the Outlier?

Profession

Mode

- 6 = Athletes
- 3 = Actors
- 4 = Personalities
- 5 = Musicians

mean

$$6 + 3 + 4 + 5 = 20$$

$$20 \div 4 = 5$$

Answer = athletes

Finding the Mean of Categorical Data?

### Major points raised during the post-lesson discussion, and the team's own opinions.

The team concluded that the students should have been given a set amount of time to complete the work. The groups' work ethic improved when they were given reminders of time remaining to complete the activity.

### Student Reflections

Reflection Sheet - 5-4-3-2-1

5 Keywords	<ul style="list-style-type: none"> <li>• Outlier</li> <li>• Mean</li> <li>• Median</li> <li>• Mode</li> <li>• Categorical</li> </ul>
4 Things I Learned	<ul style="list-style-type: none"> <li>• What types of numerical data there is</li> <li>• What types of categorical data there is</li> <li>• How to calculate the mean</li> <li>• How to calculate the Mode</li> <li>• How to calculate the Median</li> </ul>
3 New Words	<ul style="list-style-type: none"> <li>• Range</li> <li>• Outlier</li> <li>• Median</li> </ul>
2 Questions I still have	<ul style="list-style-type: none"> <li>• Examples of discrete data</li> <li>• Examples of continuous data</li> </ul>
1 Facts I already knew	<ul style="list-style-type: none"> <li>• How to calculate the mean</li> </ul>

- The definition of an outlier
- When not to use the mean
- Mode is the best to use for Categorical Data
- The difference between Categorical and Numerical Data

Celebrities make a lot of money

### Teachers' Reflections on their Lesson Study

**What did you find useful about participating in a Lesson Study?**

*What was useful? ... participating in a Lesson Study requires collaboration, working as a team with other maths teachers, developing ideas and strategies and coming up with resources to deliver the topic to students.*

*It was fascinating to see the different approaches and methodologies practiced in other schools.*

**Has participating in a Lesson Study caused you to think about your teaching in a different way?**

*Participating in the lesson study has made me reflect on the teaching methodologies I use in my own classroom, made me to reflect on how much as teachers we talk and do. It has made me think more about how I can facilitate student-centered learning; setting the students a task in order to discover the learning for themselves.*

**Having participated in one Lesson-Study cycle - can you see the difference between doing a Lesson Study for your professional development versus participating in a workshop? Consider the benefits of doing so, and the associated challenges and possible solutions.**

*Lesson Study allowed us to delve deeper and explore a specific topic whereas a workshop would be fast paced. In lesson study we had the freedom to choose a topic that we felt the students had misconceptions of, and wanted to learn how to support their learning. Lesson study made us look at how our topic is connected with other sections of their course, as well as what the students know about it from primary school, and what they need to know for Leaving Certificate. I feel this would not be made as clear in a workshop.*

*Participating in Lesson Study was initially difficult due to dark evenings and trying to arrange meetings during busy school terms, for example with staff meetings and parent-teacher meetings.*

*However, it meant, in comparison to workshops, working in a smaller group, which individual teachers found a lot more beneficial.*

**Does Lesson Study have a role in supporting other curriculum reforms e.g. junior cycle? If so, how?**

*Participating in Lesson Study makes you think a lot more about why you are teaching a certain topic, it forces you to make links with the syllabus/ specifications, the Statements of Learning of the new Junior Cycle and at a wider scale, Looking At Our School.*

*With the new Junior Cycle, we should try to engage students in 'rich tasks' where possible. Lesson Study ticks this box. By participating in Lesson Study, teachers are prepared with a model of how this could be facilitated and it allows the students to develop Key Skills.*

**Appendix 1:**

## Forbes - The World's Highest-Paid Celebrities 2018

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