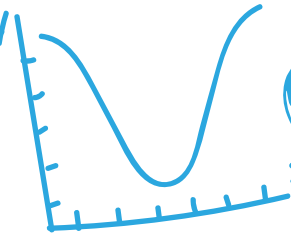
WE CAN SOLVE IT!

A FINANCIAL JUSTICE IRELAND RESOURCE FOR THE JUNIOR CYCLE MATHEMATICS CURRICULUM



Financial Justice Ireland (originally called Debt and Development Coalition Ireland) is a global financial justice organisation.

We want a fair and just society for everyone. We want a financial system that serves the needs of all people and which does not take the planet for granted. We were set up in 1993 as a response to the debt crisis in the Global South. Since that time, we have continued to lobby and campaign for sovereign debt relief, while examining different ways the structures of the international financial system can perpetuate poverty and inequality.

In 2018, on our 25th anniversary, we changed our name to better reflect our expanded areas of work. As well as working in solidarity with the Global South, we also raise awareness of how these financial issues affect people living in Ireland. Through our Development Education work we critically engage people to understand the structural causes of global inequality and power relations. We aim to empower people in Ireland to take informed action for greater economic justice globally.

To find out more about us and our work, please visit www.financialjustice.ie

This project has been undertaken with funding from Irish Aid's WorldWise Global Schools. Irish Aid's WorldWise Global Schools is the national programme of Development Education (DE) for post-primary schools in Ireland.

It is funded by Irish Aid and implemented by a consortium of organisations: Self Help Africa, Concern Worldwide and the City of Dublin Education and Training Board Curriculum Development Unit. The programme was set up in 2013 as the key channel through which Irish Aid support for DE in post-primary schools is to be coordinated. Their aim is to increase the number of post-primary schools engaging in quality development education by providing a broad range of supports.

You can find out more about WorldWise Global Schools and the work they do at www.worldwiseschools.ie

Dublin 2020

This resource was developed by Aoife Kelly with support from Julia Haimlinger and Deirdre Kelly.

A special thank you to mathematics teachers Cillian O'Neill and Helene Suttle whose contribution and advice in conceptualising the resource was greatly appreciated.

CONTENTS

INTRODUCING 'WE CAN SOLVE IT!'

A Financial Justice Ireland resource for the Junior Cycle Mathematics Curriculum

Financial Justice Ireland promotes the idea of a fair and equal global society and in particular a financial system that serves the needs of all people rather than favoured groups - a society that doesn't take the planet for granted. An opportunity was seen to link these aims to the teaching and learning of mathematics.

Through the use of this resource, students can learn about injustices in the world and be equipped with the knowledge to bring about change which can alleviate social and financial inequalities. Financial Justice Ireland saw possible links with an approach to teaching mathematics called Teaching for Social Justice and the new specification at Junior Cycle.

Recent changes at Junior Cycle provide the opportunity for students to link Mathematics to their world. Issues such as global justice, climate change and scarcity of resources are being taken up passionately by young people who are trying to change the world and the direction it is headed in. Why not provide a chance for your students to grapple with these issues and to become empowered citizens? They can work towards a fair and sustainable world while they meet the outcomes and aims of the Junior Cycle Maths Specification all the while improving their mathematical proficiency.

This resource is based around 3 sections:

1. What's Happiness got to do with it? An Exploration of Economics and Happiness
2. National Debt and Taxation
3. Environmental Sustainability

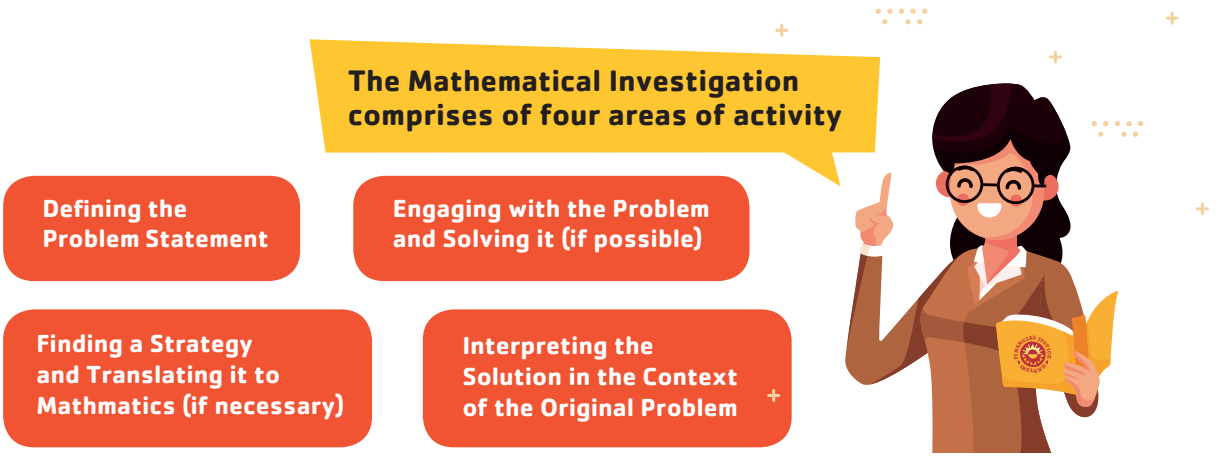
Why would I use this resource with my students?

Using this resource does not mean you have even more content to cover with your students!

The exploration of the issues around Economics, National Debt and Tax, and Environmental Sustainability will empower students to have factual knowledge on these issues and prompt them to raise awareness and challenge the status quo. The activities promote the **eight key skills** and the **five inter-connected proficiencies** highlighted in the Mathematics Specification.

Teaching mathematics in this way means that students are communicating mathematically, working as part of a team, managing information and thinking critically and creatively.

The resource also offers ideas for **Classroom projects**, where students can explore phenomena from the world around them. For example, students may decide to research "How Happy is My School?" for their statistical investigation. The section on environmental sustainability might prompt them to ask questions like "How much energy could my school generate from solar power?" The section on sovereign debt encourages them to contemplate "What does the Irish debt look like in 20 euro notes?", "Does Ireland have a Progressive Tax System?". Each of these scenarios starts with a question and then students work with others to **mathematise** the situation, and source or generate data which they analyse and report on. In these resources we have aimed to reflect the **investigation cycle** of posing a question, finding the maths, interpreting the maths, engaging with the problem and answering the question (where possible) or redefining the question. This is designed to reflect the four areas of activity involved in the **Classroom Based Assessments** in 2nd and 3rd year.



In each section the learning outcomes linked to the activities are listed. Often, on completion of the activities, the students will have a realisation of the inequity in the world, which can be difficult and often bleak to accept. In this scenario teachers can discuss ideas for activism, for example students could raise awareness about an issue or simply research what can be done on an individual and community level and what can be done on an economic policy level. The focus can be both on the inherent injustices and the steps to making things different.

Statements of learning in Junior Cycle and Financial Justice

The learning at the core of Junior Cycle is described in the twenty-four statements of learning. Each school now has a requirement to plan a curriculum which allows students to experience each of these statements throughout the course of their Junior Cycle education. The following table shows the statements which can be linked through the teaching of mathematics which is focused on Development Education and financial justice.

SOL 1	The student communicates effectively using a variety of means in a range of contexts in L1.
SOL 3	The student creates, appreciates and critically interprets a wide range of texts.
SOL 5	The student has an awareness of personal values and an understanding of the process of moral decision making.
SOL 6	The student appreciates and respects how diverse values, beliefs and traditions have contributed to the communities and culture in which she/he lives.
SOL 7	The student values what it means to be an active citizen, with rights and responsibilities in local and wider contexts.
SOL 9	The student understands the origins and impacts of social, economic, and environmental aspects of the world around her/him.
SOL 10	The student has the awareness, knowledge, skills, values and motivation to live sustainably.
SOL 14	The student makes informed financial decisions and develops good consumer skills.
SOL 15	The student recognises the potential uses of mathematical knowledge, skills and understanding in all areas of learning and describes, illustrates, interprets, predicts and explains patterns and relationships.
SOL 17	The student devises and evaluates strategies for investigating and solving problems using mathematical knowledge, reasoning and skills.

What is Teaching Mathematics for Social Justice?

Teaching Mathematics for Social Justice (TMfSJ) is an approach to mathematics education that has become increasingly visible around the globe. The principles and approach of TMfSJ greatly align with the aim of integrating issues relating to financial justice and development education with the teaching and learning of mathematics at post-primary level in Ireland.

TMfSJ is an inherently human approach to teaching and learning, in which the teacher and the students are co-creators of knowledge. By using mathematics as a tool to help students develop critical awareness and by creating classroom experiences and activities that are personally relevant to students, they can be empowered to develop a strong sense of social agency.

The approach has to do with teaching mathematics *about*, *with* and *for* social justice. Teaching mathematics *about* social justice relates to the context of the lessons which explore issues related to social injustice. Teaching mathematics *with* social justice means that the pedagogical practices and interactions are based on the principles of social justice, allowing for equal participation, collaboration and developing a sense of community in the classroom. Teaching mathematics *for* social justice refers to how mathematics can be used as a way of analysing the world and as a tool for challenging the status quo. Essentially, the mathematics gives the students the skill to "read the world" and articulate the inequalities they see around them.

How should I use this resource in the classroom?

The activities are developed so that students have an opportunity to work individually, in pairs or groups. An important aspect of the activities is communicating mathematically. The resources are enriched by asking students "So What?- your mathematics shows X, what does that mean, what do you notice about the figures, were you surprised or was it as you expected?". In this way students are developing the skills outlined in the Unifying Strand and developing mathematical proficiency through activities linked to their lives, communities and to global issues.

These activities can be used as they are laid out here or you can pick and choose from them. You may discover an area of interest and find more data online to carry out further exploration. There are possibilities for classroom based assessments (CBAs) in which students collect data on "How Happy is our School?, for example. They design questions based on indicators of happiness in school, analyse their data and present their findings. Likewise, as outlined above some of the issues raised here might provoke questions from students which they can use as the basis of their Mathematical Investigation (CBA1).

While this resource was designed to support the aims of Junior Cycle mathematics, it also offers possibilities for projects and rich tasks for Transition Year students.

I'm interested in developing my own resources, where can I get more information?

If global and social justice is an issue close to your heart there are lots of ways to bring these issues into the mathematics classroom. The following are resources that might be useful.

Financial Justice Ireland	https://www.financialjustice.ie/
Our World in Data	https://ourworldindata.org/
Christian Aid	https://www.christianaid.ie/
Teaching Maths for Social Justice	https://maths-socialjustice.weebly.com/
World Debt Clock	https://www.nationaldebtclocks.org/debtclock/ireland
World Bank	https://www.worldbank.org/
United Nations	https://www.un.org/en/
OECD	https://data.oecd.org/

SECTION 1: WHAT'S HAPPINESS GOT TO DO WITH IT?

An Exploration of Economics and Happiness

In this section, you will explore how the wealth of a nation is measured and learn about the *Happiness Index.*

Governments look at various different ways of measuring how well their country is doing in terms of making money and how happy their citizens are. The results of these measures can affect how governments make policies and this affects our daily lives. You will use your knowledge of **Statistics** to investigate some of these ways of measuring. You will learn about **Gross Domestic Product** and **Gross National Happiness** as ways that governments assess the development in their countries and those of others.

LEARNING OUTCOMES – WHAT'S HAPPINESS GOT TO DO WITH IT?

Below are the main learning outcomes which are developed in this section. Please note this list is not exhaustive.

A: UNIFYING STRAND
Element: Representation U.4 Students should be able to represent a mathematical situation in a variety of different ways, including: numerically, algebraically, graphically, physically, in words; and to interpret, analyse, and compare such representations.
Element: Connections U.5 Students should be able to make connections within and between strands U.6 Students should be able to make connections between mathematics and the real world
Element: Communication U.13 Students should be able to communicate mathematics effectively: justify their reasoning, interpret their results, explain their conclusions, and use the language and notation of mathematics to express mathematical ideas precisely.
B: STATISTICS AND PROBABILITY STRAND
SP.3 Students should be able to carry out a statistical investigation which includes the ability to: • generate a statistical question • plan and implement a method to generate and/or source unbiased, representative data, and present this data in a frequency table • classify data (categorical, numerical) • select, draw and interpret appropriate graphical displays of univariate data, including pie charts, bar charts, line plots, histograms (equal intervals), ordered stem and leaf plots, and ordered back-to-back stem and leaf plots • 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 • evaluate the effectiveness of different graphical displays in representing data • discuss misconceptions and misuses of statistics • discuss the assumptions and limitations of conclusions drawn from sample data or graphical/numerical summaries of data

LEARNING OUTCOMES – WHAT'S HAPPINESS GOT TO DO WITH IT?

C: NUMBERS STRAND
N.1 Students should be able to: • present numerical answers to the degree of accuracy specified, for example, correct to the nearest hundred, to two decimal places, or to three significant figures • convert the number p in decimal form to the form a ×10n, where $1 \leq a < 10$, $n \in \mathbb{Z}$, $p \in \mathbb{Q}$,and $p \geq 1$ (and $0 < p < 1$) N.2 Students should be able to investigate equivalent representations of rational numbers so that they can: • flexibly convert between fractions, decimals, and percentages. • use and understand ratio and proportion.

ACTIVITY 1: THINK, PAIR SHARE!

Your Principal wants to know whether the school is doing well, make a list of things that show that your school is doing a good job!

Start on your own, then share with your partner and then report back to the class

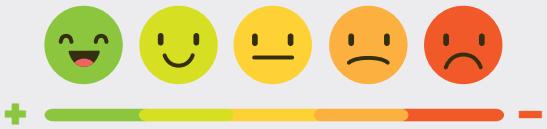
ACTIVITY 2: IS OUR SCHOOL HAPPY?

A Principal in a local school *River Grange* decides that one way of measuring whether her school is performing well is to look at the results of standardised tests in reading, writing and mathematics. She takes a **random sample** of **30** students. The grades are as follows:

Results in a standardised test:
A, B, B, D, A, E, A, C, C, A, B, E, B, B, B, C, A, B, D, D, C, C, A, A, B, C, A, B, C, B.

One of the teachers in the school suggests finding out about student wellbeing would also be a good way to see if the school is performing well. The Principal takes another **random sample** of 30 from the same group and asks them:

On a scale of 1-5, how happy are you in this school? 1 is very happy and 5 is not happy at all



What do you score on the Happiness Scale?

1	Very happy
2	Mostly happy
3	Neither happy nor unhappy
4	Sometimes unhappy
5	Very unhappy

The results of the happiness survey are as follows:

5, 1, 1, 5, 3, 4, 1, 3, 2, 5, 4, 1, 5, 4, 5, 4, 3, 3, 3, 4, 5, 4, 3, 4, 4, 4, 3, 5, 5, 2.

2.1 By choosing suitable graphs, compare the two sets of data

2.2 Describe how you could take a **random sample** of 30 students in your class.

2.3 List as many things you notice about the two graphs as you can. Do you notice any similarities and differences?

2.4 Perform some numerical analysis on the graphs (ask your teacher for help if you need to). For example what percentage of the sample scored high grades, what percentage of the group are very happy?

2.5 Report back to your Principal on which measure you think is better for judging the performance of the school. Explain your reasoning.

2.6 Write down your happiness score in school based on the scale used in the previous example____

What do you score on the Happiness Scale?

1	Very happy
2	Mostly happy
3	Neither happy nor unhappy
4	Sometimes unhappy
5	Very unhappy

2.7 A newspaper headline about the school says:

> **River Grange - Best school in the area, outstanding performance!!**

Which data set is the article focusing on, what data is it not including?

2.8 Write an alternative news headline based on the Happiness scores in River Grange. Share your headline with the class.

2.9 **EXTENSION QUESTIONS:**

1. What is a random sample?
2. Describe a method the Principal could have used to obtain the random sample?
3. What type of data was collected by the Principal? CATEGORICAL or NUMERICAL.
4. Is the data primary or secondary data? Explain your choice.
5. Is it possible to find the mean of this data? Explain your answer.

2.10 **POSSIBLE CLASS PROJECT - How happy is your class?**

Gather the data from your class on how happy they are in school and outside school.

- Design two questions to gather the data
- Use mathematics and suitable charts to analyse how happy your class is.
- Make a conclusion
- Prepare a report for your class.

ACTIVITY 3 – THE HAPPIEST COUNTRY IN THE WORLD

1.1 Can you guess the happiest country in the world? Make a prediction, explain your choice and then look it up.

1.2 Read the following paragraph and answer the questions

It's hard to believe that a tiny country tucked away in the Himalayan Mountains, locked between India and Tibet is one of the "Happiest Countries" in the world. This country is called Bhutan and has a population of approximately 800,000 people.

In 1972 the 4th King of Bhutan suggested that measuring the happiness of a nation is more important than measuring how the economy is improving. He was only seventeen at the time! He came up with the idea of Gross National Happiness (GNH) and felt it was a more holistic and sustainable approach to measuring growth by looking at Gross Domestic Product (GDP). Measuring happiness levels places the wellbeing of citizens at the centre of government policies.

Because of the King of Bhutan, countries are now interested in measuring their happiness levels and each year the United Nations publishes a World Happiness Report.

(a) Find Bhutan on a map of the world and find one other statistic about Bhutan that isn't in the paragraph above.

(b) How old is the 4th King of Bhutan now?

(c) Calculate the population of Bhutan as a percentage of the population of Ireland. How many times bigger is Ireland than Bhutan in terms of population size?

(d) Where do you think Ireland would rank in the happiest countries in the world, explain your answer.

(e) With your partner, identify the things that make citizens happy in a country.

(f) Research – In what ways does Bhutan measure happiness? Use the internet to find out!

(g) What is Gross Domestic Product (GDP)?

ACTIVITY 4: CUT OUT AND REARRANGE

The following are the top 20 happiest countries in no particular order. Their scores are ranked out of ten. With your partner or a group, rearrange them so that they are ranked from the highest to the lowest.

COUNTRY	Happiness score out of 10
United States	6.886
Costa Rica	7.072
Australia	7.272
Finland	7.632
Netherlands	7.441
Israel	7.190
Belgium	6.927
United Kingdom	6.814
Luxembourg	6.910
United Arab Emirates	6.774

COUNTRY	Happiness score out of 10
Germany	6.965
Austria	7.139
Denmark	7.555
Ireland	6.977
Iceland	7.495
New Zealand	7.324
Switzerland	7.487
Norway	7.594
Sweden	7.314
Canada	7.328

Source: http://worldhappiness.report/ World Happiness Report 2018

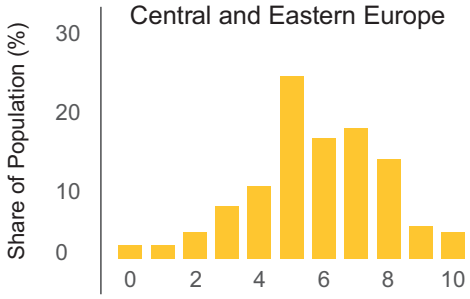
(b) Write down anything you notice about the top 20 happiest countries.

(c) By rounding the happiness scores to two decimal places, draw a graph to show the happiness levels of the top ten countries in 2018.

Extension: Ask students to round to 2 significant figures, 3 significant figures.

4.1 EXTENSION QUESTIONS:

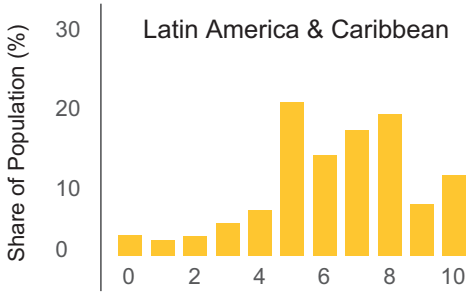
In the Happiness survey, citizens were asked "**How do you value your life**" with 0 being no quality of life and 10 being a high quality of life. The following bar charts show the results across the continents:



(a) What was the mode score in Central and Eastern Europe?

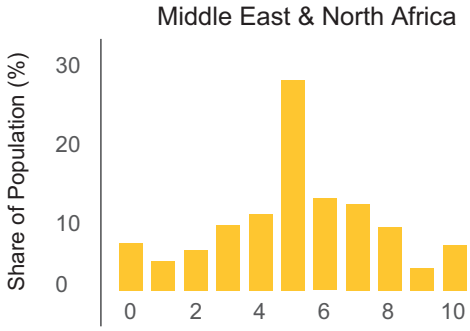
(b) What was the least popular score?

(c) Would you say that overall the quality of life is good or bad in central and eastern Europe?



(a) What was the mode score?

(b) Where do most of the scores lie?



(a) What was the mode score?

(b) What do you notice about the lower scores in this bar chart?

CONCLUSION: Which area of the world do you think has the best quality of life overall? Explain your answer.

Source: https://worldhappiness.report/ed/2017/

4.2 HOMEWORK SUGGESTION

Why are citizens in the top 20 countries happier than other countries?

Ask your parents, friends, teachers or use the internet to gather information.

Report back to the class with your discoveries!

4.3 One of the happiness indicators in the global Happiness survey is Healthy Life Expectancy. 'Healthy Life Expectancy' is an indicator used by the World Health Organisation (WHO) to measure the number of years that a person can expect to live in "full health" by taking into account years lived in less than full health due to disease and/or injury.

The following are the average (mean) life expectancies in the top eight and bottom eight countries in the survey.

Country	Average Life Expectancy in Years	Round to 2 d.p.
Italy	73.783	
South Korea	74.042	
Switzerland	73.174	
Iceland	72.756	
Spain	74.363	
Singapore	75.721	
Japan	75.088	
Sweden	72.745	

Country	Average Life Expectancy in Years	Round to 2 d.p.
Chad	45.658	
Ivory Coast	46.523	
Central African Republic	44.312	
Burundi	48.569	
Lesotho	46.480	
Nigeria	45.496	
Somalia	47.627	
Sierra Leone	43.995	

Source: World Happiness Report 2018
https://s3.amazonaws.com/happiness-report/2018/Appendix1ofChapter2.pdfw

By rounding to the nearest whole number age, draw charts to show the Healthy Life Expectancy per country for the top eight countries and the bottom eight countries.

ACTIVITY 5: WORLD MAP THINK, PAIR, SHARE

5.1 Find the countries with the highest life expectancy and mark them in on the blank map of the world. What do you notice about their location?

5.2 Find the countries on the bottom eight on the map of the world and mark them in on the blank map of the world. What do you notice about their location?

5.3 Discuss with your partner the possible reasons for a high life expectancy and a low life expectancy and report back to the class.

Gross Domestic Product (GDP) is a measure of the size of a country's economy. It is calculated by adding all the manufactured goods and services over a period of time, normally a year. It is often used to decide which countries are doing 'well.'

Source: http://mocomi.com/what-is-gdp/

5.4 Can you predict which countries in the world would be considered the wealthiest; that is have the highest GDP?

5.5 Can you predict which countries in the world would be considered the poorest in terms of wealth; that is have the lowest GDP?

ACTIVITY 5: WORLD MAP

Definition – GDP is the total value of all products manufactured and goods provided within that territory during a specific period, say a year.

Source: http://mocomi.com/what-is-gdp/

GDP is the best measure to calculate a country's economy. It includes everything produced by all the people and companies in a country

Source: http://mocomi.com/what-is-gdp/

ACTIVITY 6: RANKING COUNTRIES BY GDP

CUT OUT AND REARRANGE

Below are two tables, one represents the top twelve counties in terms of GDP and the other the bottom ten countries in terms of GDP. The countries in the top ten can be thought of as the wealthiest countries and the countries in the bottom ten can be thought of as the poorest countries in terms of wealth.

6.1 In groups cut out each country and rearrange in terms of highest to lowest

COUNTRY	GDP in millions USD $
Italy	1,934,798
China	12,237,700
United States	19,390,604
Brazil	2,055,506
European Union	17,277,698
United Kingdom	2,622,434
France	2,582,501
India	2,597,491
Germany	3,677,439
Japan	4,872,137

6.2 Look up the conversion rate for dollars to euro and convert the GDP per country to euros.

$1 USD = € _____

6.3 In groups cut out each country and rearrange in terms of the **lowest** to **highest**

COUNTRY	GDP in millions USD $
Marshall Islands	199
Tonga	426
Sao Tome and Principe	391
Nauru	114
Palau	292
Kiribati	196
Tuvalu	40
Comoros	649
Federated States of Micronesia	336
Dominica	563

6.4 Look up today's conversion rate for **dollars to euro** and convert the GDP per country to euros.

$1 USD = € _____

6.5 On your blank map mark in the top 12 countries and the bottom 10 according to GDP. What do you notice about these countries?

6.6 In your opinion, is GDP or GNH a better measure for evaluating how well a country is doing. Which is more important for governments to take into account when making new policies for the state? Explain your answer. Discuss with your partner and report back.

EXTENSION QUESTION

Convert the figures for population per continent to index notation, i.e in the form $a \times 10^n$, where $1 \leq a < 10$, $\mathbf{n} \in \mathbf{Z}$

ACTIVITY 7: WORLD WEALTH SIMULATION

You will need:

- A blank world map of the continents, preferably A3 size (see attached)
- A calculator
- 2 sets of cookie cut outs (see attached). Colour in each set a different colour. You can use real cookies or sweets if you like.
- Blu tack or sticky tape
- A group of four people

You are given the following information:

The Estimated population of the world 2017= **7.2 billion**

1 billion = 1,000,000,000

You are given 30 cookies to feed the world

You are also given the following table which shows population per continent and the GDP for each continent in 2017.

Rank	**Continent**	**GDP per capita (US$)**	**Approx. Population** Rounded to nearest million	**Cookies per population**	**Cookies per GDP**
1	Oceania	53,400	30 million		
2	North America	45,560	500 million		
3	Europe	27,330	740 million		
4	South America	9,330	420 million		
5	Asia	6,690	4.4 Billion		
6	Africa	1,820	1.2 Billion		

7.1 Label the continents on your blank map.

7.2 Using the population figures, share the 30 cookies based on the population of the continent.

Hint: Find how many people 1 cookie represents first.

With your blu tack, stick the number of cookies you have allocated for each continent on to the map.

Display your map on the classroom wall and be prepared from some questions from your teacher.

7.3 Now, using the GDP figures, share the 30 cookies based on the wealth of the continent.

Hint: Find how much money 1 cookie represents first.

With your blu tack, stick the number of cookies you have allocated for each continent on to the map.

Display your map on the classroom wall alongside the map of the cookies divided by population and be prepared for some questions from your teacher.

7.4 What do you notice about the two maps? Write down your observations here:

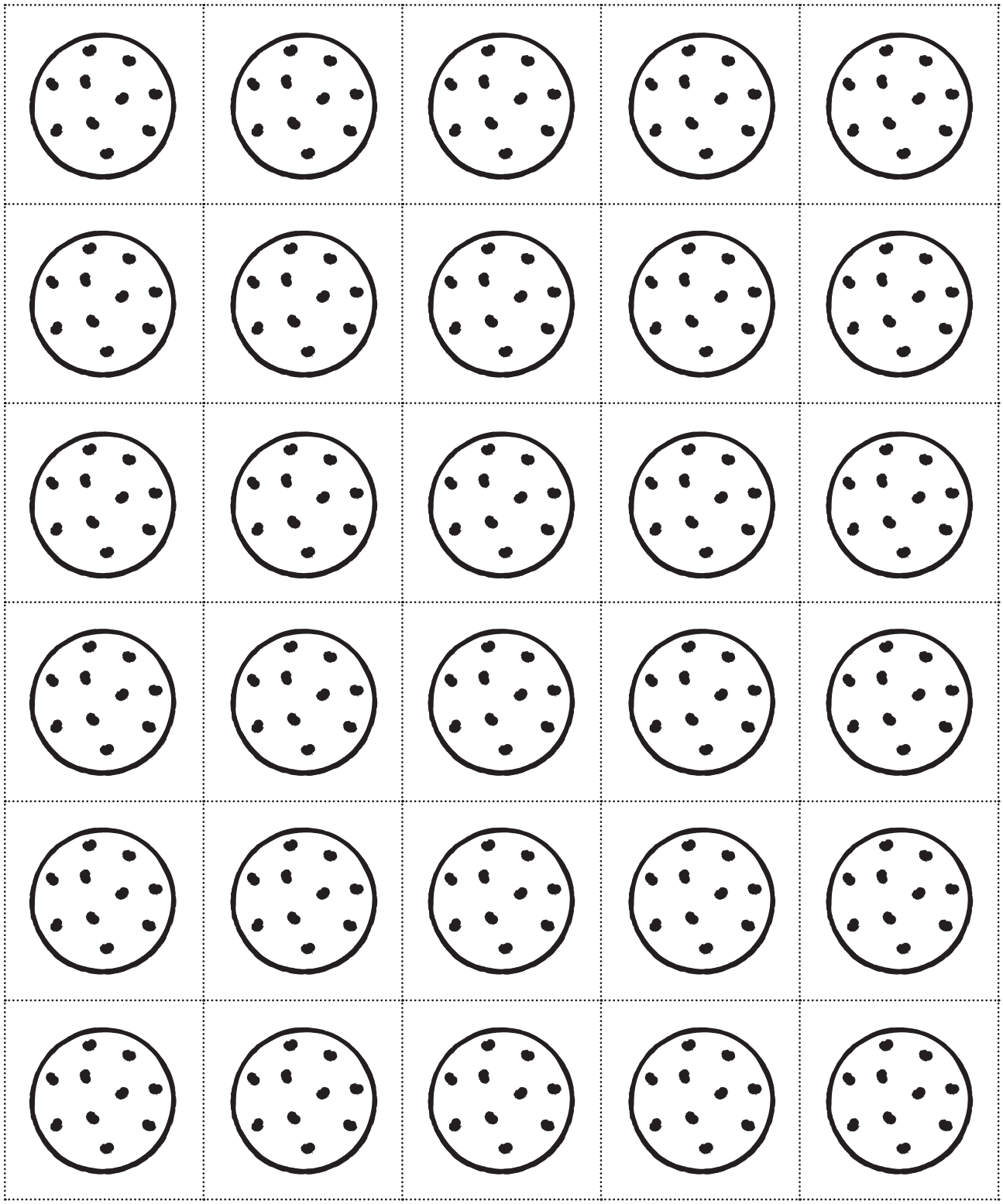
Discuss this with your class.

ACTIVITY 7: MAP OF CONTINENTS

I can label the continents of the world.

Name _____ Date: _____

ACTIVITY 7: SET OF 30 COOKIES



SECTION 2: NATIONAL DEBT AND TAX

In this section, you will learn about national debt (the money a country has borrowed) **and tax policies in Ireland and around the globe.**

Most people accept that everyone must pay tax to pay for services and for social protection, but the way in which governments tax can lead to people on low incomes paying more while other types of wealth are not taxed. We will investigate whether debt and tax policies are fair or are creating more inequality in Ireland and around the globe. And we will ask the question – Whose debt is it anyway?

LEARNING OUTCOMES – NATIONAL DEBT AND TAX

Below are the main elements and strands of the Specification which are developed in this section. Please note this list is not exhaustive.

A. UNIFYING STRAND
Element: Representation U.4 Students should be able to represent a mathematical situation in a variety of different ways, including: numerically, algebraically, graphically, physically, in words; and to interpret, analyse, and compare such representations.
Element: Connections U.5 Students should be able to make connections within and between strands. U.6 Students should be able to make connections between mathematics and the real world.
Element: Communication U.13 Students should be able to communicate mathematics effectively: justify their reasoning, interpret their results, explain their conclusions, and use the language and notation of mathematics to express mathematical ideas precisely.
B: NUMBER STRAND
N.2 Students should be able to investigate equivalent representations of rational numbers so that they can: • flexibly convert between fractions, decimals, and percentages • use and understand ratio and proportion • solve money-related problems including those involving bills, VAT, profit or loss, % profit or loss (on the cost price), cost price, selling price, compound interest for not more than 3 years, income tax (standard rate only), net pay (including other deductions of specified amounts), value for money calculations and judgements, mark up (profit as a % of cost price), margin (profit as a % of selling price), compound interest, income tax and net pay (including other deductions).
N.3 Students should be able to investigate situations involving proportionality so that they can: • use absolute and relative comparison where appropriate • solve problems involving proportionality including those involving currency conversion and those involving average speed, distance, and time.
N.4 Students should be able to analyse numerical patterns in different ways, including making out tables and graphs, and continue such patterns.

C. GEOMETRY AND TRIGONOMETRY STRAND
GT.1 Students should be able to calculate, interpret, and apply units of measure and time.
GT.2 Students should be able to investigate 2D shapes and 3D solids so that they can: • find the perimeter and area of plane figures made from combinations of discs, triangles, and rectangles, including relevant operations involving pi • find the volume of rectangular solids, cylinders, **triangular-based prisms, spheres**, and combinations of these, including relevant operations involving pi.
D. ALGEBRA AND FUNCTIONS STRAND
AF.1 Students should be able to investigate patterns and relationships (linear, quadratic, doubling and tripling) in number, spatial patterns and real-world phenomena involving change so that they can: • represent these patterns and relationships in tables and graphs
E. STATISTICS AND PROBABILITY STRAND
SP.3 Students should be able to carry out a statistical investigation which includes the ability to: • generate a statistical question • plan and implement a method to generate and/or source unbiased, representative data, and present this data in a frequency table • classify data (categorical, numerical) • select, draw and interpret appropriate graphical displays of univariate data, including pie charts, bar charts, line plots, histograms (equal intervals), ordered stem and leaf plots, and ordered back-to-back stem and leaf plots • 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 • evaluate the effectiveness of different graphical displays in representing data • discuss misconceptions and misuses of statistics • discuss the assumptions and limitations of conclusions drawn from sample data or graphical/numerical summaries of data

ACTIVITY 1: IRISH DEBT

(a) PREDICTION: How much money do you think Ireland owes to the World Bank?

(b) Go to the Debt Clock for countries in the EU and find how much these countries in Europe owe the World Bank. https://www.debtclocks.eu/public-debt-and-budget-deficit-of-ireland.html

Country	Debt	Debt per Citizen
Ireland		
France		
Germany		
Sweden		
Portugal		
Romania		
Spain		
Finland		
Greece		
Italy		
Slovenia		

(c) Why does the amount keep changing?

(d) Write Ireland's debt in words

(e) Draw a suitable chart to represent debt per citizen in the above European countries

(f) Which countries have the top three highest debts per citizen, which are the three lowest?

Highest:

1.

2.

3.

Lowest

1.

2.

3.

ACTIVITY 2: VISUALISING IRISH DEBT

(a) The picture below shows the National Debt Clock in New York. What do you think the "Family Share" means?

(b) Write the overall debt in words

_____

(c) Pair Work

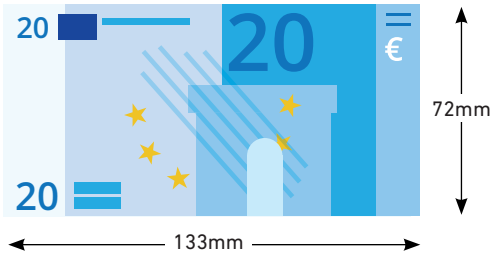
In groups of two use your maths to answer the following question:

What area of your classroom would be covered in €20 notes with Ireland's debt per citizen?

This could be used as a possible CBA 1 investigation

Hints:

- These are the measurements of a €20 note
- Measurements of my classroom
  _____ x _____
- Ireland's debt per citizen _____

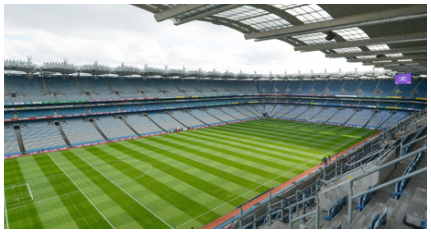


(d) Following on from your investigation, write a newspaper report on what you discovered

_____

EXTENSION QUESTION

Some students could do the same investigation with the complete National Debt and Croke Park. The pitch of Croke Park measures 145m long x 88m wide



ACTIVITY 3: WHOSE DEBT IS IT ANYWAY?

1. The table below shows Irish Sovereign (National) Debt from the year 2013 to 2018

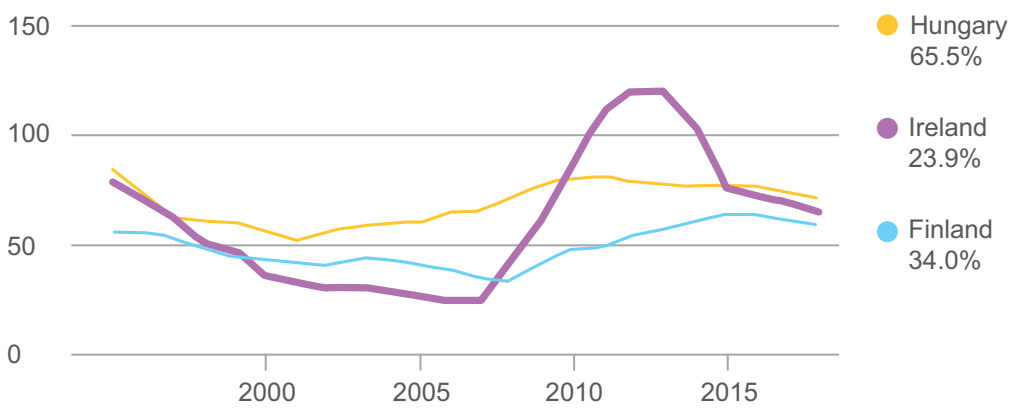
Year	Government Debt (€ billions)	Gross Domestic Product (gdp) (€ billions) Income	Debt as % of gdp (question a) (%)
2013	215.3	179.9	
2014	203.4	195.3	
2015	201.6	262.5	
2016	200.7	273.2	
2017	201.4	294.1	
2018	206.2	318.5	

Calculate the debt as a percentage of the income (GDP)

(a) Which year saw the highest debt? What was the percentage debt to GDP in that year?

(b) Would you be financially stable if you owed these percentages of your income? Explain your answer.

2. The graph below shows debt as a percentage of GDP in Ireland, Hungary and Finland

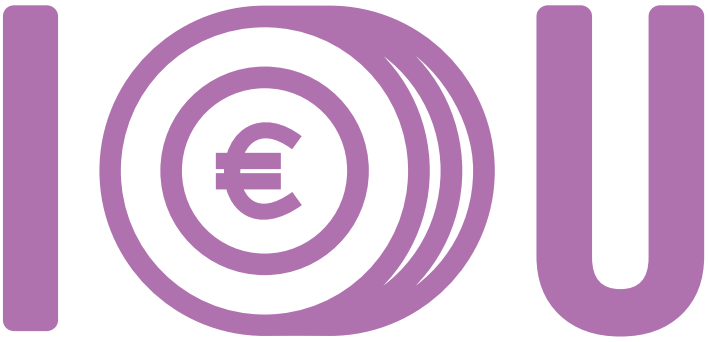


(a) Describe the overall trend for Ireland in the above graph

(b) Compare Irish government debt to that of Finland and Hungary

(c) Match the descriptions below to the parts of the graph for Ireland

A	€25 Billion in IOUs from the bank are paid by the government. This sees the debt to GDP ratio go to over 100%
B	The Government promises to pay all the debts owed by the banks
C	The Irish economy becomes more stable and the debt decreases
D	The country goes into a recession



There is a campaign called "**Not our Debt**" which is calling for the 25 billion in IOUs to be wiped from our debt.

ACTIVITY 4: TAXATION AND INEQUALITY

Despite recovery, Ireland remains a hugely unequal society.

Children and women are worst hit by a society whose policies refuse to cherish all its people equally

Wed, Aug 24, 2016

(a) Look at the headline from the Irish Times. Do you think that we live in an equal society? Explain your thinking.

(b) One mathematical way of measuring inequality of wealth (that is when there is a large gap between the richest and the poorest) is to use a number called a Gini Coefficient. The Gini Coefficient is a number between 0% and 100%, where 0% corresponds with perfect equality (where everyone has the same income) and 100% corresponds with perfect inequality (where one person has all the income—and everyone else has no income). The table opposite shows the Gini Coefficient for Ireland each year. Look at the table below, and answer the questions that follow.

Source: https://www.cso.ie/en/releasesandpublications/ep/p-syi/psyi2016/soc/si/

Year	Gini Coefficient %
2005	32.3
2006	32.4
2007	31.7
2008	30.6
2009	31.4
2010	31.1
2011	31.2
2013	31.3
2014	31.8

(i) What is the mean (average) Gini Coefficient per year. How would you interpret this – is Ireland an equal society? Explain your thinking.

(ii) Draw a suitable graph to display the data

(iii) What is the overall trend that you see in the table and the graph?

(c) The tables below show the countries with the highest Gini Coefficient and the countries with the lowest. Look at the tables and fill in the below information.

Rank	Country	Value
1	South Africa	63.40
2	Namibia	61.00
3	Botswana	60 .50
4	Suriname	57.60
5	Zambia	57.10
6	Central African Republic	56 .20
7	Lesotho	54.20
8	Belize	53.30
9	Swaziland	51.50
10	Brazil	51.30

Country	Value
Moldova	27.00
Finland	26.80
Norway	26.80
Belarus	26.70
Kazakhstan	26.50
Slovak Republic	26.10
Czech Republic	25.90
Slovenia	25.70
Iceland	25.60
Ukraine	25.50

(i) *Fill in the blanks:*

South Africa has a Gini Coefficient of _____

This means that _____

Ukraine has a Gini Coefficient of _____

This means that _____

(ii) By calculating the mean of both the countries with the highest Gini Coefficient and the lowest, comment on the average Gini coefficient for Ireland in relation to the other two means.

ACTIVITY 5: ARE ALL FAMILIES TAXED EQUALLY? (HIGHER LEVEL)

A tax system which ensures that those who have more contribute more is called a **"JUST TAX SYSTEM"**

HOMEWORK/PRIOR ACTIVITY

i. Research how the Irish tax system works and write down your findings

ii. Based on what you have found, do you think we have a system that collects tax in a way that the wealthy pay more than the less wealthy? Explain your answer.

In a system of low tax like Ireland, people have to spend more on services such as childcare, waste, travel etc. So the PAYE system seems fair but the people on low incomes can be hit the most in this type of tax system, leading to what's called the **"Low Tax Vicious Cycle"**, which is illustrated in this graphic.

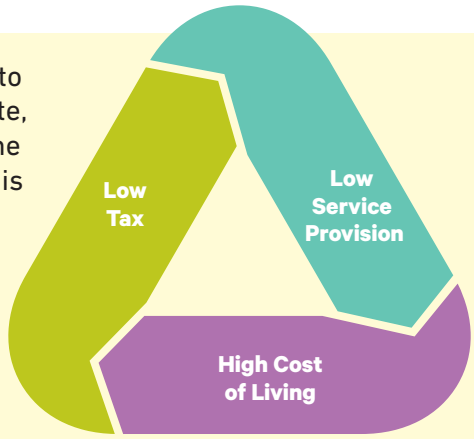


Chart: Low Tax Vicious Cycle. A vicious cycle occurs in low tax countries: they provide fewer public services, which increases the out-of-pocket expenses of citizens, who in turn are unwilling or unable to pay higher taxes.

(iii) Compare two family budgets for one year.

PART 1: INCOME

Both families have two children with a married couple and one parent working.

A. Fill in the following information in the table below:
   - The annual salary of Family A is €30,000
   - The annual salary of Family B is €100,000
   - Child benefit per child per month is €140

B. Calculate the net income tax, total USC, and the net income from the information given in the table.

Income and Tax	Family A (total for year)	Family B (total for year)
Salary		
Income Tax • Tax @ Standard Rate 20%		
Standard Rate Cut-Off Point	44300	44300
• Tax @ Higher Rate 40%		
Gross Tax		
Tax Credits*	3300	3300
Net Income Tax		
USC • First 12012 @ 0.5%		
• 12012 to 19874 @ 2%		
• 19874 to 70044 @ 4.5%		
• Above 70044 @ 8%		
Total USC		
Net Income		
Other Income		
Child Benefit		
Total Income (including Child Benefit and other income)		

C. Write the sum of the annual deductions (income tax and USC) as a percentage of total income for Family A and Family B.

* Tax credits are an important part of the tax system, and vary according to your household composition. For the purposes of this exercise we have assumed that both households include a married couple who are both working. For more information on tax credits go to: www.citizensinformation.ie/en/money_and_tax/tax/income_tax_credits_and_reliefs/introduction_to_income_tax_credits_and_reliefs.html

PART 2: EXPENSES

Fill in the table with the following information:

- Family A save €20 per month
- Family B save €2500 per month
- Family A pay €1100 per month in rent
- Family B pay €2200 per month in mortgage payments
- Family A pay €250 and Family B pay €225 per month for electricity and heat
- Both families pay €200 per month for telephone and internet
- Family A and B went on holidays in Ireland which cost €1500 and €3200 respectively
- The expenses for transport, leisure, and children are as in the table

Complete the table and calculate the balance at the end of the year.

Expenses	**Family A**	**Family B**
Financial		
• Savings	240	30000
• Credit Card	360	5400
Household Expenses		
• Mortgage/Rent		
• Electricity and Heat		
• Phone and Internet		
Transport		
• Car Loan	3000	5400
• Petrol/Diesel	4800	2400
• Public Transport	420	600
• Other	540	600
Leisure		
• Entertainment	1800	3300
• Holidays		
Children		
• School Expenses	300	800
• Clothes	200	1800
Total Expenditure		
Balance (Total Income - Total Expenditure)		

PART 3: VAT

Some goods and services we buy have a tax added (Value Added Tax - VAT). There are different rates of VAT for different products:

- 13.5% Electricity and Heat
- 13.5% Entertainment and Holidays
- 23% Petrol and Diesel
- 23% Phone and Internet

A. For each item of expenditure from the last section, calculate the proportion of the amount that was paid in VAT. The first one is done as an example.

	Family A	**Family B**
Electricity and Heat @13.5%	€3000 = (100+13.5%) €3000 = 113.5% $\frac{€3000}{113.5}$ = 1% €26.43 = 1% €26.43 x 13.5 = 13.5% €356.83 = 13.5%	
Entertainment @13.5%		
Holidays @ 13.5%		
Petrol/Diesel @ 23%		
Phone and Internet @ 23%		
Total VAT Paid		

B.

a. Write the sum of all taxes paid (income tax, USC, and VAT) for Family A and Family B as a percentage of total income.

b. Compare the answer in (a) above to the answer you found in Part 1 (C) . For which family is there a bigger change in tax rate?

REFLECTION: Based on what you have found in the above activity, do you think the tax system is a JUST TAX system? Explain your answer using statistics from your activity.

ACTIVITY 6: WORLD DEBT CASE STUDY:
THE PHILIPPINES, AN UNSUSTAINABLE BURDEN

Image taken from https://borgenproject.org/facts-about-poverty-in-the-philippines/

(i) Homework, prior to activity

Online, research how much the average Irish household spends each year on housing, heating, bills, food etc. It doesn't need to be completely accurate! Then, calculate the daily average. Report back to your class.

(ii) Currencies and poverty rates

In The Philippines, a high percentage of people live on less than **$2 a day.** Poverty in the Philippines is more persistent than other countries in South East Asia, with one in five people living below the national poverty line. The country is vulnerable to natural disasters, relies heavily on farming and has a very high population growth rate. These factors are contributing to the poverty levels.

(a) Find out today's dollar to Euro rate and convert $2 to Euro

_____

(b) With the same rate, convert the amount your household spends a day to dollars. How do the two figures compare?

(c) Find out the population of the Philippines and calculate the amount of people who are living below the poverty line.

(iii) The table below shows the Poverty Incidence in percentages in the Philippines

Year	Percentage of people on less than $2 a day
1985	35
2000	23
2006	27
2009	26
2015	22

https://psa.gov.ph/content/poverty-incidence-among-filipinos-registered-216-2015-psa

(a) Draw a suitable graph to show the above information. What do you notice about the trend in the graph you have drawn?

(b) Predict the poverty incidence rate in 2020

(iv) The table below shows the poverty incidence in Ireland

Year	Percentage below Poverty Line
2010	6.3
2011	6.9
2012	8.5
2013	9.1
2014	8.8
2015	8.7

https://www.cso.ie/en/aboutus/takingpartinasurvey/surveysofhouseholdsindividuals/surveyonincomelivingconditions/

(a) Draw a suitable graph to show the information

(b) Describe the overall trend of the data

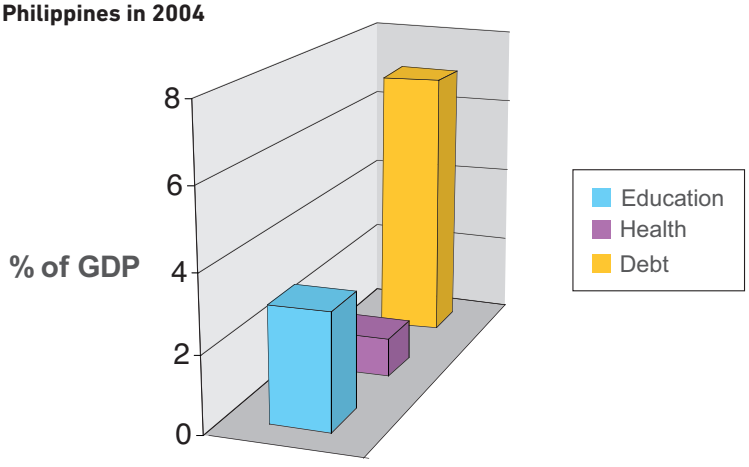
(c) How does the Poverty Incidence Rate in Ireland compare to that of the Philippines?

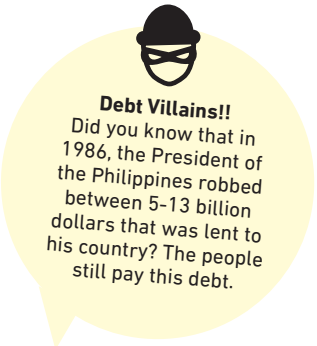
(d) In 2015, the population of Ireland was 4.678 million. How many people were living below the poverty line?

(v) Public Spending & Debt in the Philippines

When people are living in poverty, they are more reliant on public services and government spending in areas like education, health and welfare. The graph shows government spending in the Philippines in 2004.

Debt spending compared to education and health in the Philippines in 2004



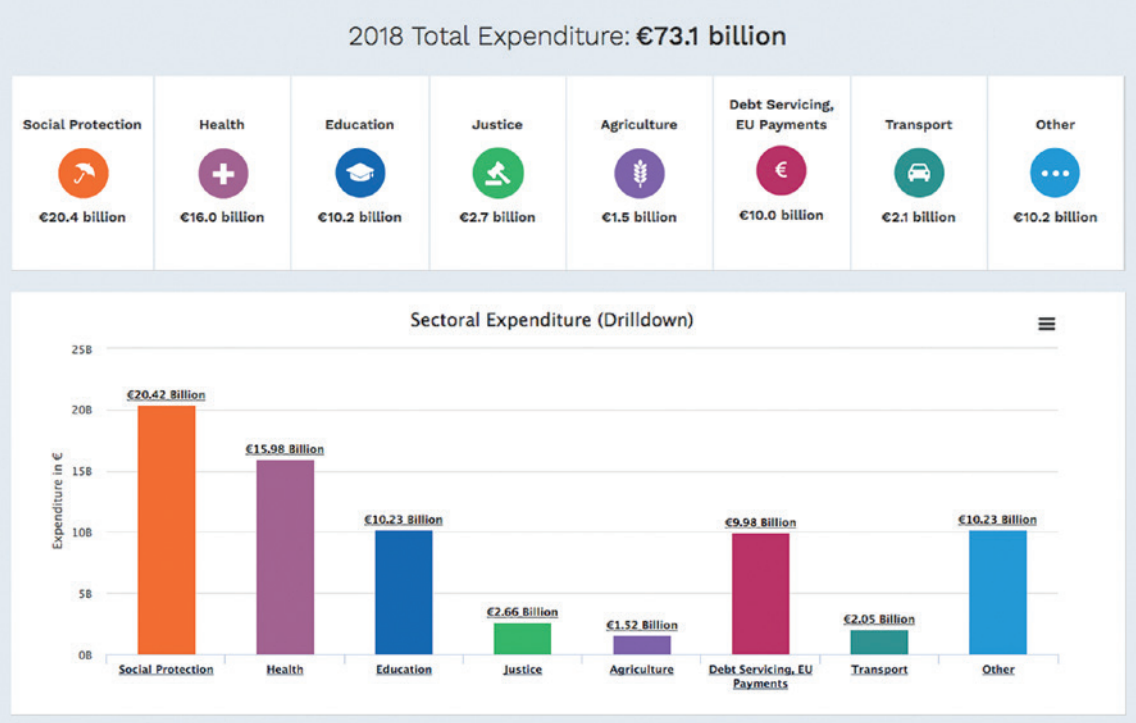


Source: http://eurodad.org/uploadedfiles/whats_new/reports/debt%20repudiation%20christian%20aid.pdf

(a) What does the above graph show about government spending in the year 2004?

(b) What was the Poverty Incidence Rate in this year in the Philippines?

The following bar chart shows Government spending in 2018



Source: https://whereyourmoneygoes.gov.ie/en/2018/

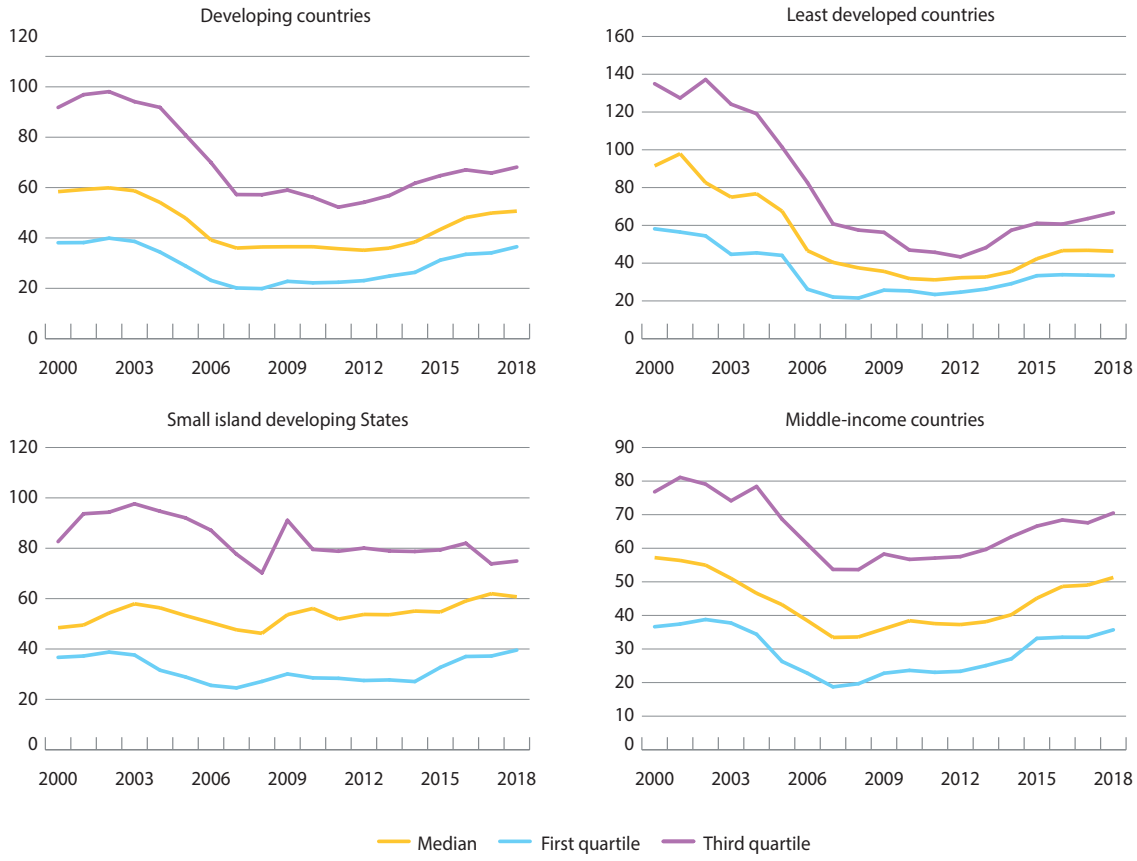
(c) By Calculating the percentage spend in the following areas in Ireland, compare the government spend in Ireland to the Philippines

Sector	Amount in €	Percentage of Budget
Health		
Education		
Debt		

ACTIVITY 7: THE UNJUST DEBT CYCLE

Look at the graphs below showing the ratio of GDP (Income) to National Debt

Figure 1
Public debt, 2000-2018
(Percentage of GDP)



Source: IMF World Economic Outlook, DESA calculations.

Source: https://developmentfinance.un.org/sites/developmentfinance.un.org/files/FSDR2019.pdf

(a) Explain the following terms and give an example of each:

- Developing Countries
- Least Developed Countries
- Small Island Developing States
- Middle Income countries

(b) Describe the overall trend of the debt in each of the graphs

Developing Countries	Least Developed Countries
Small Island Developing States	Middle Income countries

(c) In 2018 what was the median debt in each of the areas?

(d) What trend do you notice since 2010? Why do you think this is?

(e) Which category do you think the Philippines is in? Explain your answer.

(f) Why do you think the Small islands and developing states have the highest ratio of debt to income?

REFLECTION

If you are interested in knowing more about the large debts incurred by the Small Island and Developing States, look up "Climate Debt". It makes for interesting reading and links this section on National Debt and Tax to the next one on the environment and climate change.

SECTION 3: ENVIRONMENTAL SUSTAINABILITY

In this section, you will explore the effects of plastic production, use and waste on our planet.

You will also analyse the effects that increasing Greenhouse gas emissions are having on the climate and what governments have committed to doing. By working through the various activities, you will explore global injustices related to climate change and the division of resources.

LEARNING OUTCOMES – ENVIRONMENTAL SUSTAINABILITY

Below are the main learning outcomes which are developed in this section. Please note this list is not exhaustive.

UNIFYING STRAND
Element: Representation U.4 Students should be able to represent a mathematical situation in a variety of different ways, including: numerically, algebraically, graphically, physically, in words; and to interpret, analyse, and compare such representations.
Element: Connections U.5 Students should be able to make connections within and between strands. U.6 make connections between mathematics and the real world.
Element: Communication U.13 Students should be able to communicate mathematics effectively: justify their reasoning, interpret their results, explain their conclusions, and use the language and notation of mathematics to express mathematical ideas precisely.
NUMBER STRAND
N.1 Students should be able to explore numbers written as ab (in index form).
N.2 Students should be able to investigate equivalent representations of rational numbers so that they can: • flexibly convert between fractions, decimals, and percentages. • use and understand ratio and proportion.
N.4 Students should be able to analyse numerical patterns in different ways, including making out tables and graphs, and continue such patterns.
GEOMETRY AND TRIGONOMETRY
GT.1 Students should be able to calculate, interpret, and apply units of measure and time.
GT.2 Students should be able to investigate 2D shapes and 3D solids so that they can: • find the perimeter and area of plane figures made from combinations of discs, triangles, and rectangles, including relevant operations involving pi. • find the volume of rectangular solids, cylinders, triangular-based prisms, spheres, and combinations of these, including relevant operations involving pi.

ALGEBRA AND FUNCTIONS

AF.1 Students should be able to investigate patterns and relationships (linear, quadratic, doubling and tripling) in number, spatial patterns and real-world phenomena involving change so that they can:

- represent these patterns and relationships in tables and graphs.
- generate a generalised expression for linear and quadratic patterns in words and algebraic expressions and fluently convert between each representation.
- categorise patterns as linear, non-linear, quadratic, and exponential (doubling and tripling) using their defining characteristics as they appear in the different representations.

STATISTICS AND PROBABILITY

SP.3 Students should be able to carry out a statistical investigation which includes the ability to:

a. generate a statistical question.

b. plan and implement a method to generate and/or source unbiased, representative data, and present this data in a frequency table.

c. classify data (categorical, numerical).

d. select, draw and interpret appropriate graphical displays of univariate data, including pie charts, bar charts, line plots, histograms (equal intervals), ordered stem and leaf plots, and ordered back-to-back stem and leaf plots.

e. 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.

f. evaluate the effectiveness of different graphical displays in representing data.

g. discuss misconceptions and misuses of statistics.

h. discuss the assumptions and limitations of conclusions drawn from sample data or graphical/numerical summaries of data.

ACTIVITY 1: PLASTIC, PLASTIC EVERYWHERE

More plastic than fish in the sea by 2050, says Ellen MacArthur

One refuse truck's-worth of plastic is dumped into the sea every minute, and the situation is getting worse.

https://www.theguardian.com/business/2016/jan/19/more-plastic-than-fish-in-the-sea-by-2050-warns-ellen-macarthur

THINK, PAIR, SHARE

(a) How old will you and your partner beside you be in 2050?

(b) (i) How many tonnes of plastic do you think are made globally each year? Use the internet to help you.

(ii) Find out what a tonne is and explain to your class

(c) Do you think people used as much plastic in the 1950s? Explain your answer and report back to the class

The following are the figures for the amount of plastic in tonnes created each year since 1950 until 2014:

Year	Million Tonnes of Plastic
1950	2
1960	10
1970	40
1980	60
1990	80
2000	170
2010	210
2014	310

https://www.ellenmacarthurfoundation.org

(a) Draw a graph to show the number of tonnes of plastic created since 1950.

(b) What do you notice about the graph, does anything surprise you? Explain your answer.

(c) How much did plastic production increase between 1950 and 2014?

(d) When did the production of plastic really speed up? What does this look like on your graph?

(e) What was the rate of plastic production per year between 1950 and 2010?

(f) What type of relationship exists between plastic production over time?

- Linear
- Quadratic
- Exponential

Explain your answer and justify the two relations you have not selected.

(g) If plastic continues to be created at the same rate, use your graph estimate the amount of plastic which will be created in 2030?

(h) How do you feel about these figures? Why has plastic production increased so much? Talk to your parents, teachers, friends or research online. Report back to your class.

CLASS ACTIVITY/PROJECT

What does a tonne of waste look like? Bring in your used plastic and gather a tonne of waste. How can we use maths to help us with this activity?

(a) Where do you think plastic waste goes? What do you do with your plastic waste?

(b) What does the term "single-use" plastic mean?

(c) Record over a day the amount of single use plastic you use _____.

(d) In the table below, record how much single use plastic each student in your class uses per day. Is the data as you expected it? Explain your reasoning

AMOUNT OF SINGLE USE PLASTIC USED BY OUR CLASS PER DAY

Possible Classroom Project – How much plastic does a typical student in my school use per week?

It is estimated **that approximately 78 million tonnes** of plastic waste is generated each year (Ellen MacArthur Foundation 2016).

(a) What do you think happens to this waste?

(b) The table below shows where waste ends up. Find out what the words below mean, write an explanation in the table below and discuss with your class.

LANDFILL	
LEAKAGE	
INCINERATION	
RECYCLED	

(c) The table below shows where the amount of plastic waste in millions of tonnes and its destination.

	Millions of Tonnes of Waste (MT)	**Angle of sector**
LANDFILL	31.2	
LEAKAGE	25	
INCINERATION	10.9	
RECYCLED	10.9	

(i) Calculate the angle of the sector of for each type of waste disposal and record the answer in the original table. Compare with your class before you draw the pie chart.

(ii) Draw a pie chart showing destinations of plastic waste. Are you surprised by the pie chart? Discuss your reaction to the pie chart with your class.

(d) FACTS or FALSEHOODS

Tick the box based on the information in the table above

STATEMENT	TRUE	FALSE
10% of plastic waste ends up in the environment.		
Most plastic waste is recycled.		
In a pie chart. the angle of the sector "LANDFILL" is 190 degrees.		
More plastic ends up in landfill than being recycled.		
In a pie chart the angle of the sector "RECYCLED" is approximately 50 degrees.		
One twentieth of plastic waste is incinerated.		
0.1% of all plastic waste is leaked into the sea and land.		

(e) Who in the world is the worst for plastic production? Rank these areas 1st, 2nd and 3rd

Region		Plastic production
Asia		
USA and Europe		
Rest of the world		

The infographic shows the percentage of plastic production per region. One green dot = 5%. Complete the percentages per region

Region		Population	Plastic production	Percentage
Asia		4.463 billion (Wikipedia)	●●●● ●●●●●	
USA and Europe		1.686 billion	●●● ●●●●●	
Rest of the world		1.351 billion	●●●	

Question: Why do you think that Asia is the worst region for plastic production?

ACTIVITY 2 – CASE STUDY:
Corporations making millions from single use plastic

1. What is a corporation?
2. Do you know the company Nestle? Discuss with your class what products they sell.
3. Collect data from your class on the number of single use bottles of water they use per day or week. Calculate the mean, mode and median.

Read the following article about Nestle and answer the questions on the next page.

Nestlé Makes Billions Bottling Water It Pays Nearly Nothing For

The company's operation in Michigan reveals how it's dominated the industry by going into economically depressed areas with lax water laws.

In rural Mecosta County, Michigan, sits a near-windowless facility with a footprint about the size of Buckingham Palace. It's just one of Nestlé's roughly 100 bottled water factories in 34 countries around the world.

Inside, workers wear hairnets, hard hats, goggles, gloves, and earplugs. Ten production lines snake through the space, funneling local spring water into 8-ounce to 2.5-gallon containers; most of the lines run 24/7, each pumping out 500 to 1,200 bottles per minute. "Daily, we're looking at 3.5 million bottles potentially," says Dave Sommer, the plant's 41-year-old manager, shouting above the din.

Silos holding 125 tons of plastic resin pellets provide the raw material for the bottles. They're molded into shape at temperatures reaching 400F before being filled, capped, inspected, labeled, and laser-printed with the location, day, and minute they were produced—a process that takes less than 25 seconds. Next, the bottles are bundled, shrink-wrapped onto pallets, and picked up by a fleet of 25 forklifts that ferry them to the plant's warehouse or loading docks. As many as 175 trucks arrive every day to transport the water to retail locations in the Midwest. "We want more people to drink water, keep hydrated."

Source: https://www.bloomberg.com/news/features/2017-09-21/nestl-makes-billions-bottling-water-it-pays-nearly-nothing-for

(a) Buckingham Palace has an area of 77,000 m^2. Sy calculating the approximate area of your school, estimate how many schools the size of yours would fit on the footprint of a Nestle water facility.

(b) The article says that in the factory "*Ten production lines snake through the space, funnelling local spring water into 8-ounce to 2.5-gallon containers.*"

Using these conversions, convert these bottles into millilitres and litres

1	=	3.78541	1	=	29.5735
US liquid gallon		Litre	US fluid ounce		Millilitre

8 Ounce bottle = _____

2.5 Gallon bottle = _____

(c) How many bottles are produced on a yearly basis from this facility?

(d) By using your yearly figures and the answer from part (c), calculate how much plastic is created and used by this facility in Michigan per year.

(e) Why do you think Nestle want "more people to drink water, keep hydrated"?

Think, pair, share

(f) Bring in a 250ml bottle of water to maths class, and by taking whatever measurements you can, calculate the amount of plastic needed to create a single bottle of water.

Note: Discuss with your class the best estimate and strategy and decide which answer is the most accurate

Reflection:

- Do you think Nestle wants the people in the developing countries such as India, Bolivia and African nations where it is buying up water supplies to stay hydrated?
- What are the long term effects of freshwater being privatised?

5. Read the text below about water privatisation

Water privatisation: Corporate vs. civic control

Water is a right and can be conserved for the benefit of all. But as scarcity increases, water's value as an economic commodity rises—and multinational companies are only too eager to profit from this deteriorating situation by buying up water rights on every continent. Privatisation is another major threat to the world's freshwater supply.

About 90 percent of the world's freshwater stocks currently remain under public control, but privatization is becoming more common as revenue-strapped governments increasingly cannot afford to maintain and repair crumbling municipal water purification and delivery systems often built decades ago. Historically, however, in places where privatisation has been established, it has proven to be another cause of—rather than a solution to—chronic water shortage problems. That is, because corporations are (by their nature) more concerned with making money than serving people's and communities' best interests, water privatization has led to corruption, lack of corporate accountability, loss of local agency, weakened water quality standards, and steep rate hikes that eliminate poor people's access to water.

- **Example: Nestlé in the US**: Nestlé, one of the largest food corporations in the world, is also in the water business, leasing or owning 50 spring sites throughout the US. However, in many places where Nestlé operates, they have unlawfully extracted water from aquifers, engaged in price-gouging tactics, and polarised communities. Over the next decade Nestlé will extract 650 million gallons of Arkansas Valley water so that every day they can load 25 trucks with 8,000 gallons of water, drive 120 miles to a bottling plant in Denver, and fill millions of plastic Arrowhead Springs water bottles to be sold in the western US. In addition to being targeted by locals who want control of their water sources back, Nestlé is also at the epicenter of the growing bottled water controversy. That is, American consumers purchase about 28 billion bottles of water every year, but recycle only about 23 percent of the plastic petroleum-based containers used for water or soda. The rest end up polluting roadsides, landfills and oceans, and leach toxins into ecosystems while taking about a millennium to degrade.

Reflection:

Considering the text you just read what are the possible consequences if our freshwater stock is being privatised? Share thoughts with the person next to you.

3, 2, 1....WRITE DOWN:

(a) Write down:

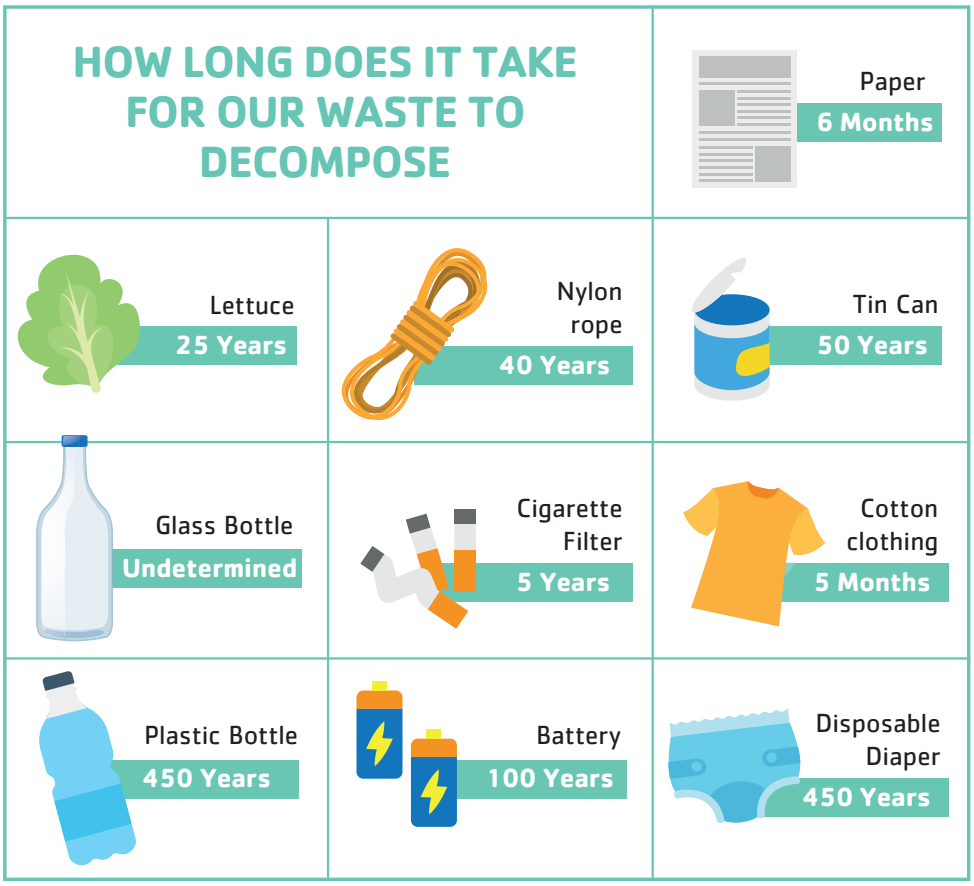
- 3 statistics you read on page 49.
- 2 Things you didn't understand.
- 1 Thing you would like to know more about.

Share your list with the class to help you understand the article on page 49.

(b) Based on your calculation of the area of a 250ml water bottle on the previous page, calculate how many tonnes of plastic is used by American consumers for the purposes of drinking water.

(c) Calculate how much of this plastic will end up in landfill and oceans.

(d) Using the chart, calculate accurately how long it will take for the 28 Billion bottles of water used by Americans every year to decompose.

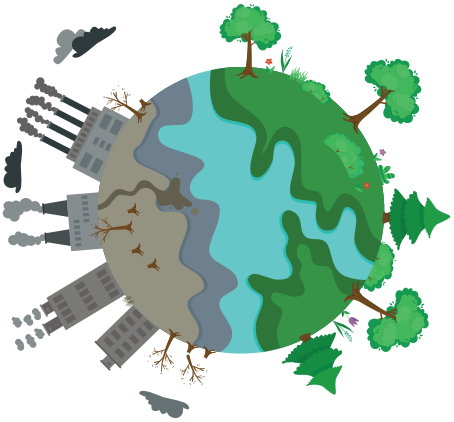


Makes you think about grabbing a convenient soft drink right!! Millions of barrels of Oil are used to make the plastic and more for transport

ACTIVITY 3: CLIMATE CHANGE AND GLOBAL INJUSTICE

‘Our house is on fire’: Greta Thunberg, 16, urges leaders to act on climate

Scientific evidence paints a clear picture: Climate change is happening, it is caused in large part by human activity, and it will have many serious and potentially damaging effects in the decades ahead. Greenhouse gas emissions from cars, power plants and other man-made sources—rather than natural variations in climate—are the primary cause. These emissions include carbon dioxide — the main greenhouse gas — which has reached a concentration level in our atmosphere that the Earth hasn’t seen for more than 400,000 years. These greenhouse gases act like a blanket, trapping the sun’s warmth near the earth’s surface, and affecting the planet’s climate system.



Source: https://www.c2es.org/content/climate-basics-for-kids/

1. What do you think Greta is referring to when she says our “House is on Fire?

2. The table shows the amount of CO_2 in the earth’s atmosphere since 1960

Year	Concentration of CO_2 in ppm (parts per million)
1960	319
1970	323
1980	337
1990	358
2000	370
2018	408

Source: https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions

(a) Draw a graph to show the CO_2 in the atmosphere per year

(b) What do you notice about the graph, what's the general trend?

(c) What type of relationship exists between the level of CO_2 over time? Explain why you eliminated 2 of the choices

LINEAR QUADRATIC NEITHER

(d) Use your graph or table to predict the levels of CO_2 in 2050

(e) Which decade saw the biggest increase in concentration of CO_2?

3. Which countries do you think produce the MOST and LEAST CO_2 emissions? Work with your partner to make 5 predictions in each category.

MOST	LEAST
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

4. The following table shows the carbon emissions per year of some of the countries in the world.

Country	Population	MT CO_2/YR
Australia	24.6 million	402
Canada	37.06 million	617
China	1.386 billion	10877
EU	513.5 million	3548
India	1.339 billion	2454
Japan	126.8 million	1320
Russia	144.5 million	1764
US	327.2 million	5107
UK	66.04 million	379
Ireland	4.784 million	38
Cayman Islands	61,559	0.5
Cook Islands	17,379	0.05
Faroe Islands	49,290	0.002
Saint Lucia	178,844	0.4
Samoa	196,440	0.15
Seychelles	95,843	1
Kiribati	116,398	0.03

https://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions

(a) Reorder the countries from the highest to the lowest Carbon Dioxide emissions. What do you notice about the countries with the highest emissions and the countries with the lowest?

(b) What kind of countries have the lowest emissions? Where are they located?

(c) Why do you think these countries have low CO2 emissions? Explain your reasoning.

FACTS or FALSEHOODS

Tick the box based on the information in the table above:


STATEMENT	TRUE	FALSE
The United States has the highest CO_2 emissions in the world.		
Kiribati emits less than 1% of the CO_2 emitted by Ireland.		
The lowest CO_2 emissions on the above table is the Faroe Islands.		
The difference between the highest and the lowest emissions in the table is 10,876.998 $MTCO_2$/YR.		
Over 15 years the UK will release 1895 $MTCO_2$ if the rate stays the same.		
Canada's emissions are approximately 6% of China's.		
Chinas carbon emissions per year can be written as 10,877, 000 tonnes of CO_2.		

5. Study the picture below and read the headline.

While my island nation sinks, Australia is doing nothing to solve climate change

The inaction and recalcitrance of Australia's federal politicians is making Kiribati despair

▲ Part of the village of Elita in the nation of Kiribati, which is only two metres above sea level and is already feeling the impact of rising sea levels. Photograph: Jonas Gratzer/Lightrocket via Getty Images

https://www.theguardian.com/world/commentisfree/2018/oct/10/while-my-island-nation-sinks-australia-is-doing-nothing-to-solve-climate-change

(a) By writing as a fraction, compare Kiribati's CO_2 emissions to Australia's, what do you notice about the two figures?

(b) Based on the headline about rising sea levels in Kiribati, what do you think the injustice here is?

ACTIVITY 4: SUSTAINABLE ENERGY AND OUR SCHOOL

Sometimes thinking about climate change can be worrying, but there are changes we can make that help our planet, reduce waste and lower fossil fuel emissions. One of those things is harnessing solar energy.

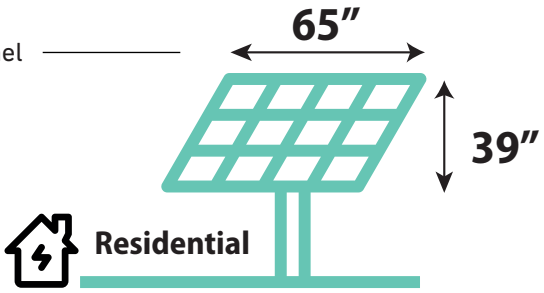
Watch this short video about solar power:

https://www.youtube.com/watch?v=bhcIJRdyrQg#action=shar

1. How much energy could your school generate from Solar Panels each year?

You are given the following information:

- These are the measurements for one solar panel



- The formula to calculate
  Energy generated in Kilowatts/ hour is

  E = A x r x H x PR

  A = Surface Area of the solar panels

  r = Efficiency rating = 0.23

  H = Global radiation value = 4037

  PR = Performance Ratio = 0.25

- The solar panels should face the south to maximise energy from the sun

GROUP TASK:

(a) By converting the imperial measurements to metric, and estimating the number of panels which will fit on the roof of your school, calculate the Energy generated in kWh per year.

(b) The average household in Ireland uses 4,300 kwH of electricity per year. How many households could be run by your school's potential solar power?

(c) It costs approximately €7,000 to install solar panels for a typical house. If the government met its climate change targets and avoided its fine of €150 million, how many houses could be set up with solar panels?

ACTIVITY 5: FOSSIL FUEL EMISSIONS

1. THINK, PAIR, SHARE

(a) Write down anything you know about fossil fuels and share with the class

(b) The United Nations have agreed a list of Global Warming Potentials (GWP) for Greenhouse Gases. The GWP tells us how much global warming each gas causes. The values for three common gases are given below:

Gas name	Global Warming Potential
Carbon dioxide	1
Methane	28
Nitrous oxide	265

(Source: IPCC Fifth Assessment Report)

All Greenhouse Gases (GHGs) can be converted to their Carbon Dioxide Equivalent.

Methane has a GWP of 28, meaning that 1 tonne of methane released into the air has the same effect as releasing 28 tonnes of Carbon dioxide.

(c) What is the Carbon Dioxide Equivalent of 5 tonnes of methane?

(d) What is the Carbon Dioxide Equivalent of 5 tonnes of nitrous oxide?

(e) How many more times worse for global warming is nitrous oxide than methane? Express your answer:

(i) as a ratio, and

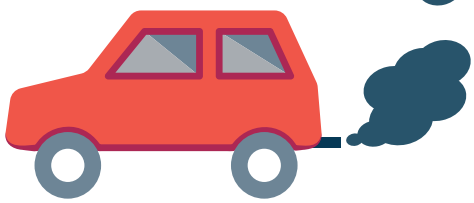
(ii) as a percentage

(f) Complete the table below, which shows the typical emissions from a family car.

The Carbon Dioxide Equivalent can be calculated as follows:

Carbon Dioxide Equivalent = No. of Tonnes released x Global Warming Potential

Gas	**Tonnes released**	**Global Warming Potential** (GWP)	**Carbon Dioxide Equivalent** (Tonnes)	**% contribution of gas** (as a percentage of total)
Carbon dioxide	5	1		
Nitrous oxide	0.5	265		
Methane	0.16	28		
		Total:		



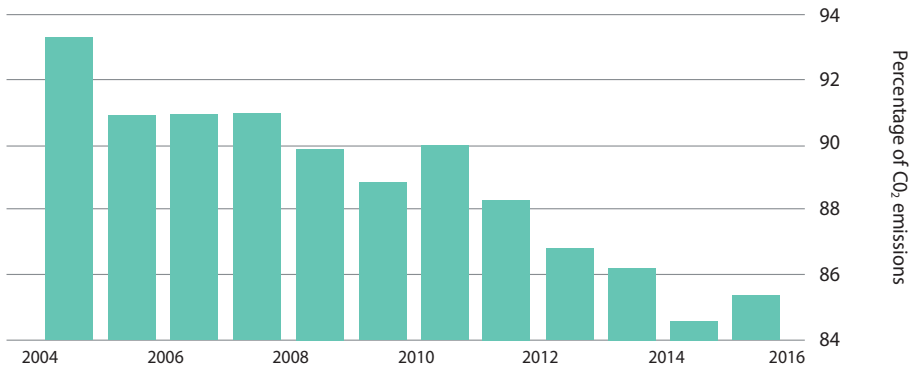
Source: Statistics Canada, Greenhouse Gas Emissions from Private Vehicles in Canada, 1990 to 2007, 2010, Catalogue no. 16-001-M

(i) Are you surprised by the figures? What measures can be taken to cut down on these emissions?

2. IRELAND AND GREENHOUSE GASES

Ireland currently has the 3rd highest rate of CO_2 emissions per capita in Europe. In the Paris agreement, the government committed to reduce emissions by 20% by 2020 compared to 2005.

(a) By looking at the graph below, which shows greenhouse gases as a percentage of all emissions, deduce whether Ireland is on track to meet this promise. Explain your reasoning.



(b) If Ireland doesn't meet these targets, we will face fines of approximately €150 million. The graphic below shows the government spend from 2018.

If Ireland pays the fine, what percentage of the overall spend from 2018 would that be?

Calculate the cost of the fine as a percentage of

(i) Education spending in 2018

(ii) Health spending in 2018

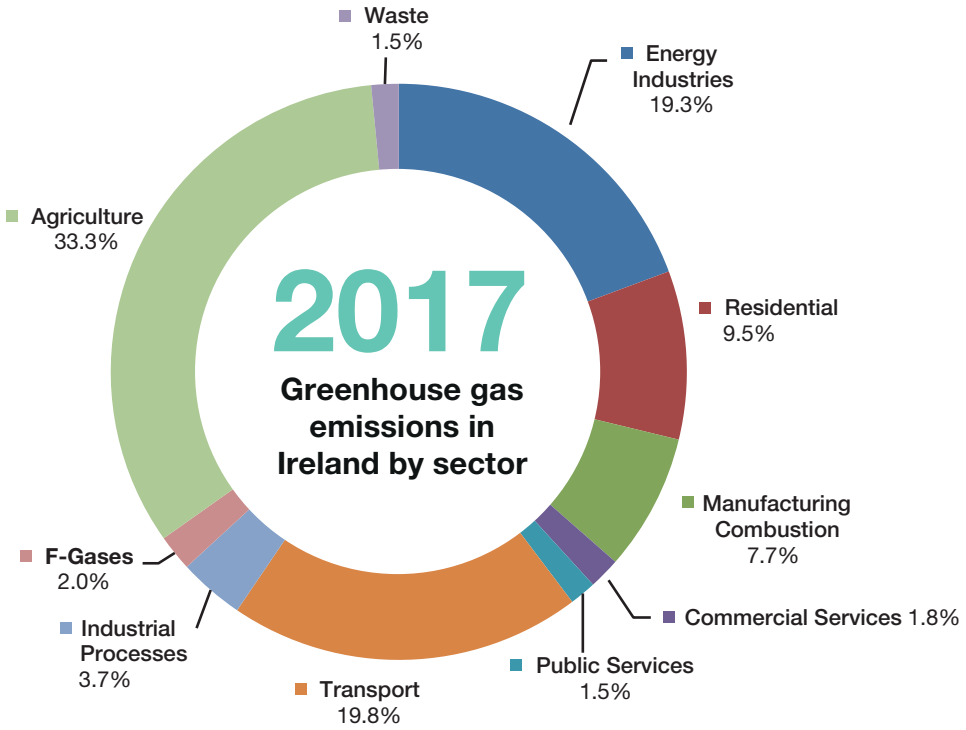
(c) A number of local councils in Ireland have been introducing water fountains in public areas to help people cut down on single use plastic bottles, but many areas lack this service. Each fountain costs approximately €2000 to buy and install.

https://www.thejournal.ie/councils-look-to-install-public-water-fountains-to-reduce-plastic-bottles-4314241-Nov2018/

(i) Calculate to the nearest water fountain how many of these could be purchased with the 150 million fine?

(ii) If the water fountains were divided equally between all the counties, how many would that be per county?

(d) Look at the pie chart below published by the Environmental Protection Agency showing the source of Greenhouse gas emissions in Ireland and answer the questions.



(a) Which 3 sectors show the highest rate of Greenhouse gases?

Source	% emissions

Which 3 sources have the lowest Greenhouse gas emissions

Source	% emissions

(i) What is the percentage from residential properties?

(ii) Based on the chart do you think it would be fair to introduce a household Carbon Tax (that is a charge for using oil, petrol, diesel, gas, coal or peat or any fuel that creates carbon)? Explain your reasoning.

(iii) List some other ways the Government could help reduce the Green House Gas emissions.

ACTIVITY 5 HIGHER LEVEL

These tables show the emissions from developed countries and small island developing countries since 1850.

CO_2 emissions per person for selected countries

List 1: Small Island Developing States

Small Island Developing States	Historic emissions (Tonnes of CO_2 emitted per person from 1850 to 2012)	Current tonnes of CO_2 emitted per person, per year
Guyana	100	2.6
Grenada	59	2.3
St Lucia	55	2.3
St Vincent and the Grenadines	47	1.9
Dominica	45	1.9
Maldives	43	3.3
Tonga	32	1.1
Samoa	29	1.0
Papua New Guinea	16	0.8
Kiribati	16	0.6
Cabo Verde	15	0.9
Vanuatu	15	0.6
Sao Tome and Principe	13	0.6
Solomon Islands	12	0.4
Haiti	5	0.3
Comoros	5	0.2
Guinea-Bissau	5	0.2
Marshall Islands	N/A	1.9
Micronesia	N/A	1.4
Tuvalu	N/A	1.0
Timor-Leste	N/A	0.4

List 2: Richer States

Richer states	Historic emissions (Tonnes of CO_2 emitted per person from 1850 to 2012)	Current tonnes of CO_2 emitted per person, per year
United States	1,167	16.5
United Kingdom	1,106	6.5
Germany	1,055	8.9
Belgium	1,034	8.3
Canada	815	15.1
Russia	717	11.9
Australia	655	15.4
Poland	631	7.5
Netherlands	628	9.9
Kuwait	614	25.2
France	525	4.6
Norway	415	9.3
Ireland	411	7.4
Japan	400	9.5
Italy	360	5.3
New Zealand	346	7.7
United Arab Emirates	318	23.3
Saudi Arabia	307	19.5
Spain	266	5.0
South Korea	265	11.6
China	111	7.5

Source (https://jubileedebt.org.uk/wp/wp-content/uploads/2018/10/Dont-owe-shouldnt-pay_10.18.pdf)

(a) What do you notice about the two tables ?

(b) Complete the following frequency table, based on the 'Historic Emissions' column of both lists:

Hint: The Frequency here means the number of countries which fall into each category according to their emissions

Historic Emissions (Tonnes of carbon dioxide)	0-200	200-400	400-600	600-800	800-1000	1000-1200
Frequency						

(c) Draw a histogram using the data in the table above.

(d) Use mid-interval values to calculate the mean historic emissions from this table (show your workings).

(e) Imagine that country X has emitted exactly the mean historic emissions. Would you expect country X to be a Small Island Developing State or a Richer State? Explain your answer.

ACTIVITY 6: CURRENT EMISSIONS FROM DEVELOPING AND RICHER COUNTRIES (HIGHER LEVEL)

(a) Calculate the mean value for 'Current tonnes of CO_2 emitted per person, per year' for both lists:

- Small Island Developing States - Mean CO_2 emitted: _____ per person per year
- Richer States - Mean CO_2 emitted: _____ per person per year

Put the values for 'Current tonnes of CO_2 emitted per person, per year' from both tables into a back-to-back Stem and Leaf plot (The first value in each list has been entered for you):

List 1: Small Island Developing States		List 2: Richer States
2	0	
	1	
	2	
	3	
	4	
	5	0
	6	
	7	
	8	
	9	
	10	
	11	
	12	
	13	
	14	
	15	
	16	

Key: 0|4 = 0.4

Calculate the median for both lists (show your workings).

What does the difference in the median of the two lists tell you about the data?

Other than a back-to-back Stem and Leaf plot, what other types of graph or chart could have been used to show this data?

Do you think a back-to-back Stem and Leaf plot is a good way of presenting this data? Give a reason why?

Use the completed back-to-back Stem and Leaf plot to find the median and mode of both lists:

Small Island Developing States - Median CO_2 emitted: _____ per person per year

Modal CO_2 emitted: _____ per person per year

Richer States - Median CO_2 emitted: _____ per person per year

Modal CO_2 emitted: _____ per person per year

You have been asked to pick an average to compare both lists. For these two lists, which one measure of average (mean, median or mode) do you think would be the most appropriate to use. Explain your reason for choosing this average:

☐ Mean ☐ Median ☐ Mode

Reason:

ACTIVITY 7: EFFECTS OF CLIMATE-RELATED DISASTERS

Changes in the global climate increase the risk of extreme weather disasters. Increase in the air and water temperatures leads to rising sea levels, supercharged storms and higher wind speeds, droughts, heavier rainfall and flooding.

Table 1: Largest relative economic damage from climate-related disasters

Country	Year	Disaster	Economic damage as percent of GDP	Total damage	Government debt year before the disaster	Government debt two years after
Dominica	2017	Storm	330%	$2,000,000,000	73%	N/A
Grenada	2004	Storm	150%	$889,000,000	80%	93%
Dominica	2015	Storm	90%	$482,810,000	81%	69%
Vanuatu	2015	Storm	60%	$449,400,000	21%	39%
Guyana	2005	Flood	35%	$465,100,000	119%	60% Got HIPC and MDRI debt relief
Belize	2000	Storm	35%	$277,460,000	47%	83%[14]
Tonga	2001	Storm	30%	$51,300,000	32%	41%[15]
Belize	2001	Storm	30%	$250,000,000	67%	96%[16]
Haiti	2016	Storm	25%	$2,000,000,000	30%	N/A
Bahamas	2004	Storm	20%	$1,550,000,000	27%	30%
Samoa	2012	Storm	15%	$133,000,000	42%	54%
Tajikistan	2008	Extreme temperature	15%	$840,000,000	34%	37%
St Vincent and the Grenadines	2013	Flood	15%	$108,000,000	72%	79%
Fiji	2016	Storm	15%	$600,000,000	48%	N/A

Source (https://jubileedebt.org.uk/wp/wp-content/uploads/2018/10/Dont-owe-shouldnt-pay_10.18.pdf)

Use the table above to estimate the Gross Domestic Product (GDP) of the list of countries.

Use these GDP to estimate Government Debt before disaster and Government Debt two years after disaster (both are shown as % of GDP in the table above).

In the last column, write the change in debt from before to after the disaster.

Country name	Disaster year	GDP ($)	Debt before disaster ($)	Debt two years after disaster ($)	Change in debt (+/-)
Grenada	2004	592,666,667	474,133,334	551,180,000	+ 77,046,666
Dominica	2015	536,455,556	434,529,000	370,154,334	- 64,374,666
Guyana	2005				
Belize	2000				
Bahamas	2004				
Samoa	2012				
Tajikistan	2008				

Why do you think some countries debts increased after the disasters, while others' decreased? Give two possible reasons for an increase and for a decrease.

In September 2018, the Jubilee Debt Campaign said that:

> **"The true climate debt is owed by those who have contributed most to climate change, and it is owed to those who are most severely impacted. It is a moral outrage that those who are most affected by climate change are being made to take on debts because of the disasters that climate change is exacerbating."**

Do you think the statistics in this section support this claim?

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