

# QCA-RSS Centre Review

## Statistics and Handling Data Project

### World Population

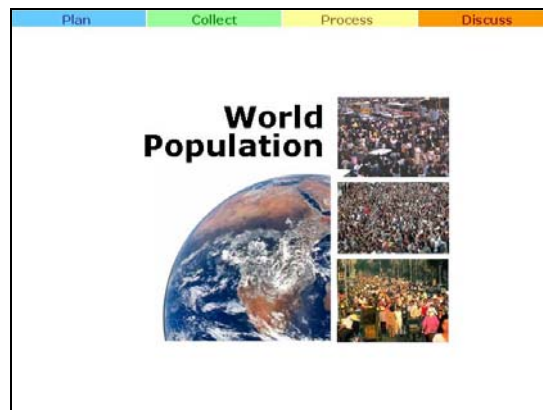
Notes for PowerPoint Presentation

#### Objectives

Children should learn:

- to relate individual statistical techniques to a wider problem;
- to think analytically about a statistical problem;
- to apply a variety of techniques to solve a problem;
- to know that mathematical models are used to help understand situations;
- general population knowledge.

#### Slide 1



The PowerPoint presentation contains 29 slides. A number of these are either optional or used for transitions between the different sections (a map of the problem solving approach is used for this).

The presentation requires Microsoft PowerPoint version 2002 and above. If you have an earlier version you can download software to view (but not edit) our files. The viewer can be obtained for free from [www.microsoft.com/powerpoint/](http://www.microsoft.com/powerpoint/) (search with the key word "viewer").

#### Context

In 1999 the World's Population broke the 6 billion barrier. Scientists have used various models, including bacteria, to simulate world population growth – many suggest we are in a time of exponential growth and that the world will reach a stationary period at 10 billion – after this it is expected that the population size will remain static or decline. This unit focuses on issues surrounding population – how figures are reported, what factors affect population growth and comparing the growth in different countries.

#### Activities (Approx 30 minutes)

Worksheet 1 could be used here to help engage students with the problem. It involves students:

1. Estimating populations (of school through to country)
2. Ordering countries in order of size of population
3. Researching population figures using the internet
4. Sensibly rounding population values

# World Population

## Objectives

Children should learn:

- the context of the problem;
- to ask questions about presented information;
- to know that mathematical models are used to help understand situations;

## Slides 2 & 3

The image shows two presentation slides side-by-side. Both slides have a header with four colored tabs: Plan (blue), Collect (green), Process (yellow), and Discuss (orange).  
Slide 2 is titled "World Population" and features a globe. The text on the slide reads: "Every second the number of people in the world grows. How many people do you think there are in the world at this moment? How many babies do you think will be born during this lesson?"  
Slide 3 is also titled "World Population" and features a petri dish. The text on the slide reads: "If the population is increasing, will we ever run out of space? If so, when might it happen? What is the maximum number of people the world can support? To help answer this scientists have studied the way bacteria grow on a petri-dish filled with nutrients. They start with a few bacteria and give them lots of food (nutrients) and space in which to multiply."

- How do you think these figures are calculated?
- What factors affect population growth?
- Is the population growing faster or slower than you expected?
- How fast do you think the population in the UK is growing?
- Can you read the World's Population as a number?

The underlined link to the population calculator works using Internet Explorer (or other browser). You need Macromedia Flash player installed for it to display correctly – if you are having problems viewing it you made need to update your flash viewer. This can be done through the site:

[http://www.adobe.com/shockwave/download/download.cgi?P1\\_Prod\\_Version=ShockwaveFlash](http://www.adobe.com/shockwave/download/download.cgi?P1_Prod_Version=ShockwaveFlash)

## Activities

Discussion based on questions posed.

Optional activity: (15-20 mins approx) using M&M's to model population growth and decay. This resource is adapted from [www.pbs.org](http://www.pbs.org) and provides an interactive introduction to mathematical modelling which can be used to introduce the bacterial model.

## Points to note:

Scientists formulated the **natural growth model** for biological populations with an unlimited supply of food - suggesting that the growth rate is proportional to the population, ie double the population and the birth rate doubles (or  $dP/dt = kP$ )

For the model of bacteria in a petri dish the food is limited and the population soon reaches a maximum and then declines.

As far back as 1798 Thomas Malthus concluded that left unchecked, it would only be a matter of time before the World's Population would be too large to feed itself.

# World Population

## Objectives

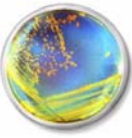
Children should learn:

- to plot a line graph
- to look at a simple model as a representation of a more complicated situation;
- to make predictions about what might happen next.

## Slide 4

Plan   Collect   Process   Discuss


### World Population



When each bacterium has had enough nutrients it divides in two.  
If it does not manage to take in enough nutrients it dies.  
Let's use a computer model to see what happens as the bacteria multiply over time.

Plan   Collect   Process   Discuss

### World Population



Time (minutes)	Number
0	1
20	3
40	6
60	10
80	19
100	38
120	66
140	89
160	104
180	131
200	157
220	180
240	183
260	181

Task : Plot the population number against time.

## Activities

Students plot the graph on the pupils' worksheet – the numbers have been simplified (under ideal conditions bacterial numbers can reach millions in a few hours, in this model space is limited).

Why is TIME on the x axis?

This fits the standard of the independent variable (time) on the x axis and observed variable (population number) on the y-axis.

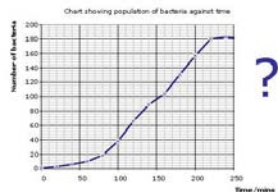
## Slide 5

Plan   Collect   Process   Discuss

### World Population

Your graph should look something like this.

Chart showing population of bacteria against time



What do you think will happen to the bacteria next?

This screen shows the completed graph for comparison.

The question is given here to allow discussion of what will happen to the numbers next – the image is repeated to show that the bacteria are reaching the limits of the petri dish – their numbers should soon drop/decline.

# World Population

## Objectives

Children should learn:

- to interpret graphical information;
- to look at a simple model as a representation of a more complicated situation;
- about the four stages of growth - it is not important to know the exact meaning of each term.

## Slides 6 & 7

The image shows two presentation slides side-by-side, each with a header bar containing the words 'Plan', 'Collect', 'Process', and 'Discuss' in colored boxes. The left slide is titled 'World Population' and features a globe icon. It contains a graph of a bacterial growth curve with four phases: Lag, Log, Stationary, and Death. The y-axis is labeled 'Number' and the x-axis is 'Time'. Text on the slide explains that scientists have discovered that bacteria follow this pattern and asks what is happening during the 'stationary' phase, with a hint: 'as quickly as new bacteria are appearing...'. The right slide is also titled 'World Population' and asks 'Do you think that the human population grows in the same way as the bacteria?'. It shows two graphs: the top one is a smooth bacterial growth curve, and the bottom one is a jagged world population curve. It asks 'Perhaps the World's Population will move into the death phase? Is it steady or still racing up?' and includes a small 'Human growth curve' label at the bottom right.

Under good conditions bacteria adhere to the basic Natural Growth Curve which has four stages:

The lag phase is so-called as the population growth is small and so growth rate is small – hence lagging. During the log phase the growth is 'explosive' (exponential) – new bacteria are appearing at a faster rate than the older bacteria are dying. In the Stationary phase, the death rate = the growth rate. This occurs as space becomes limited and food supply is insufficient. The Death phase occurs as food is no longer available and no new bacteria are appearing.

Is the actual world population curve likely to be:

1. as smooth?
2. the same shape?

In the model the bacteria run out of food and space – provided humans are able to replace the food their numbers will not fall. It is likely to have an extended 'stationary' period and hopefully not go into full decline.

# World Population

## Objectives

Children should learn

- that individual countries have different growth patterns;
- estimation of the World's Population comes from country-by-country data;
- to form and investigate hypotheses.

## Slide 8 & 9

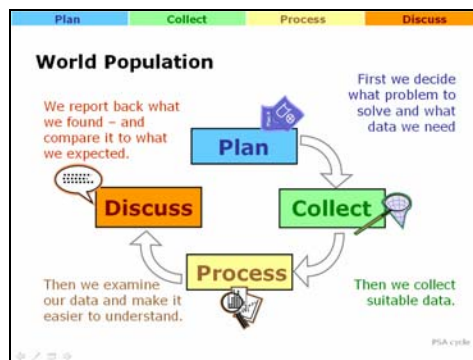
**Slide 8: World Population**  
Collecting data for the whole world is difficult.  
We can think of each country (or continent) as a separate petri dish (of different sizes).  
Are there parts of the world that have **steady** populations, others which are still **increasing** and others in **decline**?

**Slide 9: World Population**  
Which parts of world do you *think* might have  
• a **steady** population?  
• an **increasing** population?  
• a **declining** population?  
Something you believe might be true is called a **hypothesis**.  
For example  
**"I believe Mexico has a steady population."**  
To help investigate a hypothesis, we can use the **Problem Solving Approach**...

These two slides are used to get pupils to consider how growth around the world could be in different stages of the growth curve.

Depending on the ability of the group you might want to give them an open choice of country or direct them to particular examples. European countries tend to show slow growth becoming almost steady eg Sweden, Germany) whereas IndoAsia (Pakistan, India) are still rapid. Other good examples which show changing growth rates include South Africa and Zimbabwe.

## Slide 10



This slide introduces the Problem Solving Approach that will be used during this investigation. It is repeated several times during the investigation to show the progress being made.

These materials have been designed so that students can see how individual elements relate to a whole problem solving approach.

# World Population

## Objectives

Children should learn

- to make and justify predictions relating to data
- to plan what data they will need to address their question;
- to think about where they can get relevant data from;
- that data can be obtained from primary and secondary sources.
- how hypothesis writing fits into problem solving
- to make and justify predictions relating to data

## Slide 11

**Plan** | Collect | Process | Discuss

### World Population

Which part of world are you going to look at?  
What do you think is happening to the population there?  
What might be causing the population to grow like that?

Write your ideas down, see if you can form them into a **hypothesis**.  
"I think that....because...."

**Important:** It doesn't matter if your hypothesis is wrong, because you'll always learn something new from the data!

Your Hypothesis

**Plan** | **Collect** | Process | Discuss

### World Population

What information do we need to collect?  
How far back in time should/can we go?


Types of data

Pupils could be given an area to look at or select themselves – if groups are directed to study particular parts of the world their results can be shared and compared with other groups' results in the later stages. In planning what to collect pupils could be asked:

- What data is needed to investigate the pupils' questions?
- What is the best way to collect the data?
- Where can you get the most reliable data from?
- How are we going to record the data?

This is an opportunity for students to plan **how** they will collect the data, think of an appropriate way of recording the data and discuss measurement.

Note: The next slide contains a discussion of primary and secondary data sources – this can be accessed using the button in the bottom right. If this is not clicked, the next slide is ignored.

## Slide 13 Optional

**Plan** | **Collect** | Process | Discuss

### World Population

Can we use **primary** or **secondary** data?

There are good and bad things about both types of data.  
Can you think what some of them are?

<b>PRIMARY DATA</b>	vs.	<b>SECONDARY DATA</b>

What sort of data can we use in this investigation?

Types of data

Which is appropriate in this case? (SEE SLIDE 15 TOO)

It may be possible to divide the class into groups and get them to collect data from different sources enabling comparison at the end, and a discussion about reliability.

If possible, it is advantageous to allow the students to explore the data on their own – studies have shown that they engage with a problem best when they collect the data themselves.

# World Population

## Objectives

Children should learn:

- to think about where they can get relevant data from;
- that data can be obtained from primary and secondary sources.
- how their current task fits within the whole 'problem solving approach'.

## Slides 14 & 15

The Problem Solving Approach

World Population

It is difficult to find the world's *actual* population; we use estimates based on national censuses and calculations using birth and death rates.

A number of websites contain information on population sizes.

U.S. Census Bureau [census.gov](http://census.gov)

POPULATION REFERENCE BUREAU [prb.org](http://prb.org)

wikipedia.org [unfpa.org](http://unfpa.org)

Slide 14 highlights our position in the problem solving approach; we have decided what to collect.

Slide 15 shows some websites which contain fairly reliable population estimates. Individual countries take censuses once every ten years (on average); in between years are therefore estimated. Flagging this as a problem now helps with discussion later on once they have collected the data.

Wikipedia could also be used as an additional source which itself has links to other online resources. In addition it contains pictorial representations of the distribution of the World's Population. See [en.wikipedia.org/wiki/World\\_population](http://en.wikipedia.org/wiki/World_population)

## Slide 16 & 17

World Population

[www.rsscse.org.uk/qca/population](http://www.rsscse.org.uk/qca/population)

A webpage will appear with your selected data.

First choose "Total Population"

Then select a country

Choose the years you want to use. (1950 onwards)

World Population

A webpage will appear with your selected data.

If you want to use this data as a spreadsheet (to use in Excel) then click on File → Save As. Then rename the file to **population.CSV**

Year	Population	Population
1950	2512214000	2512214000
1951	2527000000	2527000000
1952	2541800000	2541800000
1953	2556600000	2556600000
1954	2571400000	2571400000
1955	2586200000	2586200000
1956	2601000000	2601000000
1957	2615800000	2615800000
1958	2630600000	2630600000
1959	2645400000	2645400000
1960	2660200000	2660200000
1961	2675000000	2675000000
1962	2689800000	2689800000
1963	2704600000	2704600000
1964	2719400000	2719400000
1965	2734200000	2734200000
1966	2749000000	2749000000
1967	2763800000	2763800000
1968	2778600000	2778600000
1969	2793400000	2793400000
1970	2808200000	2808200000
1971	2823000000	2823000000
1972	2837800000	2837800000
1973	2852600000	2852600000
1974	2867400000	2867400000
1975	2882200000	2882200000
1976	2897000000	2897000000
1977	2911800000	2911800000
1978	2926600000	2926600000
1979	2941400000	2941400000
1980	2956200000	2956200000
1981	2971000000	2971000000
1982	2985800000	2985800000
1983	3000600000	3000600000
1984	3015400000	3015400000
1985	3030200000	3030200000
1986	3045000000	3045000000
1987	3059800000	3059800000
1988	3074600000	3074600000
1989	3089400000	3089400000
1990	3104200000	3104200000
1991	3119000000	3119000000
1992	3133800000	3133800000
1993	3148600000	3148600000
1994	3163400000	3163400000
1995	3178200000	3178200000
1996	3193000000	3193000000
1997	3207800000	3207800000
1998	3222600000	3222600000
1999	3237400000	3237400000
2000	3252200000	3252200000
2001	3267000000	3267000000
2002	3281800000	3281800000
2003	3296600000	3296600000
2004	3311400000	3311400000
2005	3326200000	3326200000
2006	3341000000	3341000000
2007	3355800000	3355800000
2008	3370600000	3370600000
2009	3385400000	3385400000
2010	3400200000	3400200000
2011	3415000000	3415000000
2012	3429800000	3429800000
2013	3444600000	3444600000
2014	3459400000	3459400000
2015	3474200000	3474200000
2016	3489000000	3489000000
2017	3503800000	3503800000
2018	3518600000	3518600000
2019	3533400000	3533400000
2020	3548200000	3548200000
2021	3563000000	3563000000
2022	3577800000	3577800000
2023	3592600000	3592600000
2024	3607400000	3607400000
2025	3622200000	3622200000
2026	3637000000	3637000000
2027	3651800000	3651800000
2028	3666600000	3666600000
2029	3681400000	3681400000
2030	3696200000	3696200000
2031	3711000000	3711000000
2032	3725800000	3725800000
2033	3740600000	3740600000
2034	3755400000	3755400000
2035	3770200000	3770200000
2036	3785000000	3785000000
2037	3800000000	3800000000
2038	3815000000	3815000000
2039	3830000000	3830000000
2040	3845000000	3845000000
2041	3860000000	3860000000
2042	3875000000	3875000000
2043	3890000000	3890000000
2044	3905000000	3905000000
2045	3920000000	3920000000
2046	3935000000	3935000000
2047	3950000000	3950000000
2048	3965000000	3965000000
2049	3980000000	3980000000
2050	3995000000	3995000000

If Internet access is available to pupils they can be shown how to use the simplified request form that is hosted on the QCA site – this is linked to the US Census world database.

The URL shown is an active hyperlink to the website which has estimated population numbers – based on birth rates, death rates and census data for individual countries. The data runs from 1950 onward – dates beyond 2006 can be used and estimated numbers will be provided (up to and including 2050).

Copying the data directly from the webpage and pasting it into Excel can cause problems – the two columns when pasted default as one column! Instead save the webpage onto the Desktop or My Documents as "population.CSV" – it is important to use the ".CSV" ending.

Double clicking on this file will open it up in Excel – it may require a little tidying up but the data will be stored in two separate columns!

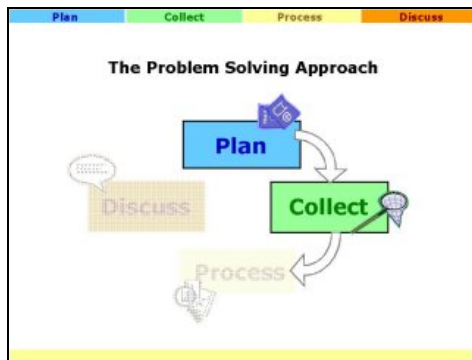
# World Population

## Objectives

Children should learn:

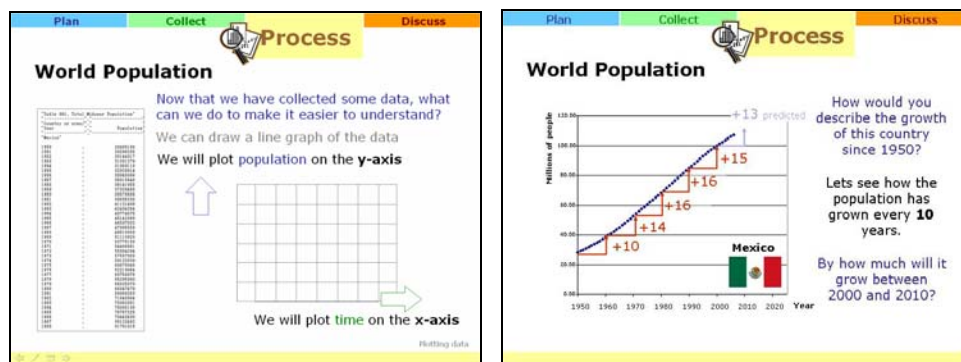
- to think about variables and the best way to process them;
- that graphs and charts can be used to gain additional information;
- how the current task fits within the whole 'problem solving approach'.

## Slide 18



This slide shows which stage in the Problem Solving Approach we have reached having specified our key questions and collected some data – we are now ready to process the data. We need to get it into a form that is easier to manage by drawing some graphs and charts and doing some calculations.

## Slides 19 & 20



Pupils could plot their results now or wait until after both slides have been discussed.

An additional discussion could be about why **time** is plotted on the x-axis and **population** on the y-axis; this is the expected standard for an independent or selected variable (time) against dependent or measured variable (population).

Data for Mexico is plotted for each year from 1950 to 2006. The population is increasing at a reasonable pace, but beginning to slow down.

To help investigate the growth curve steps are plotted for every 10 years. Pupils should suggest an estimate for the final step (2000-2010) before it is revealed.

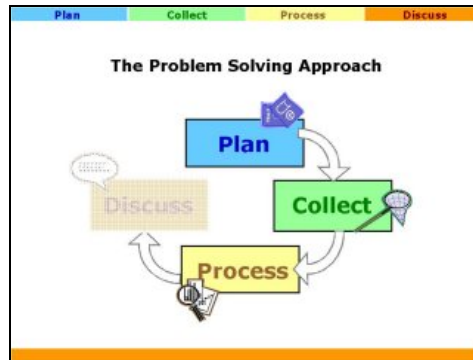
# World Population

## Objectives

Children should learn:

- to relate their investigation back to the original problem;
- that investigating a problem often leads to new questions being asked.
- how their current task fits within the whole 'problem solving approach'.

## Slide 21



This slide shows which stage in the Problem Solving Approach we have reached having processed some data – we are now ready to discuss what we have found from the data.

## Slide 22

Slide 22 is titled 'World Population' and is set against a background with a progress bar at the top showing 'Plan' (blue), 'Collect' (green), 'Process' (yellow), and 'Discuss' (orange). The 'Discuss' stage is highlighted with a speech bubble icon. The main content includes the following text and a graph:

**World Population**

Describe the growth curve for your chosen population.  
Where do you think the country is on the growth curve?

What do you think will happen to this country over the next

- 10 years (decade)?
- 100 years (century)?

Could you work out the maximum population your country is likely to reach?

The graph shows a simple growth curve with 'Population' on the vertical axis and 'Time' on the horizontal axis. The curve starts at the origin, rises to a peak, and then begins to level off.

This slide is used to remind us of the initial questions asked during the planning stage:

- Where on the simple growth curve is the World's Population?
- What will happen to the population over time?

These can be edited or other questions could be added.

Depending on the ability of the group they could be asked to comment on the accuracy of the figures. For example, in the UK the census is taken only once every ten years. Population figures for the next nine are then based on calculations. For the country they are investigating they could try and find out when the last full census was taken.

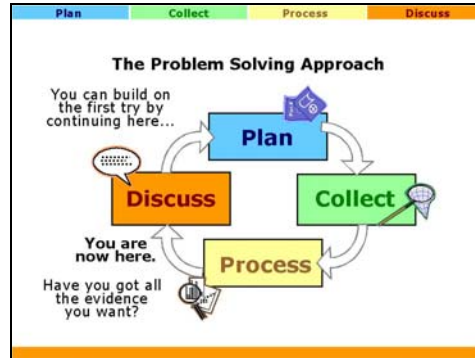
# World Population

## Objectives

Children should learn:

- to relate their investigation back to the original problem;
- that investigating a problem often leads to new questions being asked.
- how the current task fits within the whole 'problem solving approach'.

## Slide 23



This is the final screen, from a series of similar screens, showing which stage in the Problem Solving Approach we have reached.

Having discussed our findings we could now start the whole cycle again. Some additional ideas are introduced on the next slide.

## Slide 24

The slide is titled 'World Population' and features a horizontal bar at the top with four colored segments: blue for Plan, green for Collect, yellow for Process, and orange for Discuss. The main content includes: 'Some additional investigations:' followed by two bullet points: 'How fast is the population growing in your country compared to' and 'neighbouring countries?' and 'richer or poorer countries?'. Below this, it says 'You may like to continue your investigation by considering household size in the UK or population pyramids in different countries:'. At the bottom, there are two buttons: 'Household numbers' with the subtext 'Size of family' and 'Population pyramids' with the subtext 'Number of women'. A small footer text 'Extending the work' is visible at the bottom right.

This slide is used to extend the investigation and takes us into a new planning stage:

- What impact does household size have on population growth?
- OR How do factors such as a country's age profile influence its growth?

These can be edited or other questions could be added.

# World Population

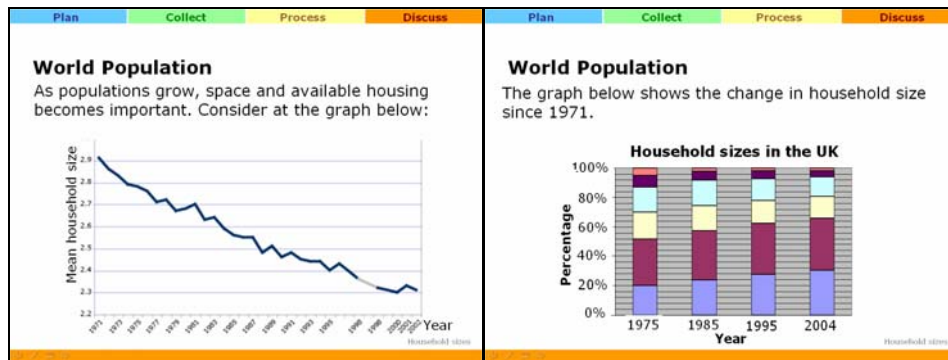
## Objectives

Children should learn:

- how their current task fits within the whole 'problem solving approach';
- that investigating a problem often leads to new questions being asked.

Investigating Household numbers

Slides 25 & 26



## Points to note

This is the last slide in this section. Further investigation should be carried out independently.

There is the chance here to extend or improve the investigation. Discussion can centre on the questions on the slide

Students could collect household size data for their group and plot the average on this graph. It is likely that their average is significantly higher than 2.32 – **why is this? Is there bias involved? What is problematic about the sample group? Ext: Which average is best?**

Decreasing household size is a matter of concern in the UK. There are various reasons that it is happening – some are more sensitive than others: family breakdown, more people choosing to delay having children, people living longer. As a result of decreasing household size, more space is needed to house the population. This leads to concern about whether and when we may run out of space.

[The mean is best for roughly normally distributed data, and the median is best for skewed data – by plotting data from a single year you can see the data is positively skewed. For higher ability children this is something worth exploring. **Why has the mean been chosen? What difference would choosing the median make?**]

The General Household survey is carried out annually and is available online:

<http://www.statistics.gov.uk/ghs/> all the presented data is taken from this survey. It is a difficult site to navigate but there is a lot of information available.

Alternatively, investigation could be into household size around the world (data and an interactive map available at

<http://www.sasi.group.shef.ac.uk/worldmapper/display.php?selected=191#> ) and the possible links between household size and birth/death rates.

Students can create a stacked bar to represent their class data.

The site [www.sasi.group.shef.ac.uk/worldmapper](http://www.sasi.group.shef.ac.uk/worldmapper) could be used to investigate birth rates and other factors relating to population growth and decline.

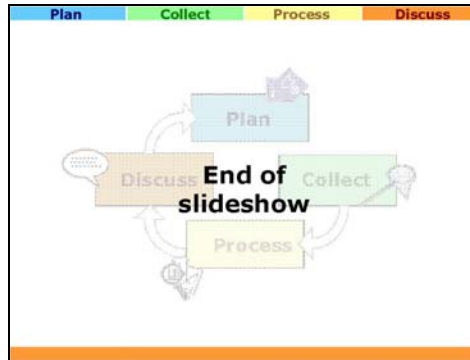
# World Population

## Objectives

Children should learn:

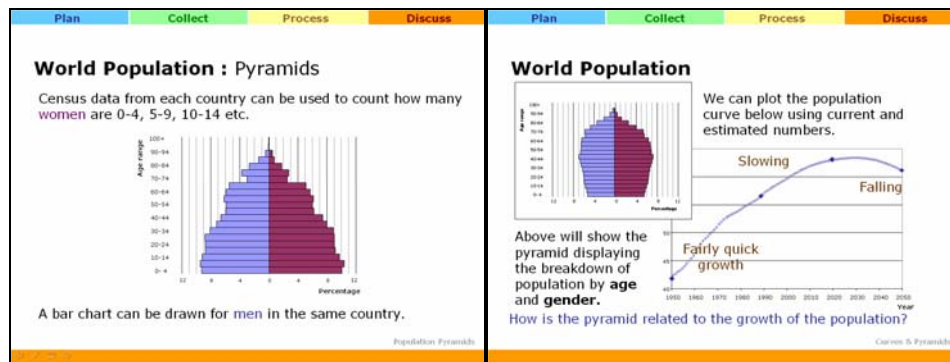
- how their current task fits within the whole 'problem solving approach';
- that investigating a problem often leads to new questions being asked.

## Slide 27



## Investigating Population Pyramids

## Slides 28 & 29



The birth rate of a country is closely linked to the number of number of women of childbearing age; CBA is difficult to define, as there are often older and younger exceptions. A suitable choice might be 15-44 since the datasets available group by the ages 10-14, 15-19, 20-24 etc.

A population pyramid is shown on the first slide by creating two bar charts side by side.

The second slide then shows (for France) how population growth has slowed and is likely to go into decline. This is revealed at the same time as several snapshots of population pyramids.

Pupils hopefully will see that once a population pyramid becomes top heavy the country will go into decline – too many older people not being replaced by enough young.

# World Population

## Objectives

Children should learn:

- how their current task fits within the whole 'problem solving approach';
- that investigating a problem often leads to new questions being asked.

## Slide 30

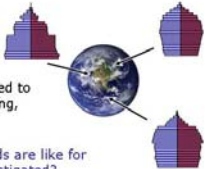
Plan Collect Process Discuss

### World Population

Different parts of the world have different population pyramids.

A country's pyramid can be used to suggest if the country is growing, steady or in decline.

What do you think the pyramids are like for countries which you have investigated?

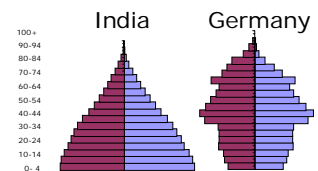


This slide links this new factor back into their previous work looking at countries around the world. If they have found a rapidly growing country and a steady country are there differences in the pyramids?

You could discuss the pyramids on the slide and whether the countries are likely to be growing quickly or not. Students could also predict which countries they might represent and look for similar pyramids.

Data on population pyramids can be found at the website below. Choose "**Population, by Age and Sex**" in the top option box and repeat as instructions given earlier (see slide 16).

[www.rsscse.org.uk/qca/population.htm](http://www.rsscse.org.uk/qca/population.htm)



If you are interested in looking at regions of the UK, the census 2001 part of the ONS site has population pyramids for different regions of the UK. See [http://www.statistics.gov.uk/census2001/pop2001/Nottingham\\_UA.asp](http://www.statistics.gov.uk/census2001/pop2001/Nottingham_UA.asp) for an example and links to others.

## Slide 31

