NZ Statistics Teacher's Day
Tuesday 26 November 2013

Changing Teaching Statistics
Real Data, Real learning

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Back-up notes for the PowerPoint presentation. This is divided into four parts.

1. ***GettingtothePoint***
   - Google-maps based distance tool
2. ***ExperimentsAtSchool***
   - Simple online experiments
3. ***Stats2013AtSchool***
   - World-wide online statistics quiz
4. ***Data Visualisation***
   - How you can help.

1 GettingtothePoint online mapping Tool

(i) There is a strong linear relationship between the straight line ('as-the-crow-flies') and road distances between two points A and B.

- The mapping tool can be used to obtain and upload these distances
- The uploaded distances can be retrieved to create teaching and learning resources
- Simple analyses that include looking at the data through dot plots and scatter plots can lead to interesting investigations and discussion.
- Cross curricular activities, for example in geography, can be developed.

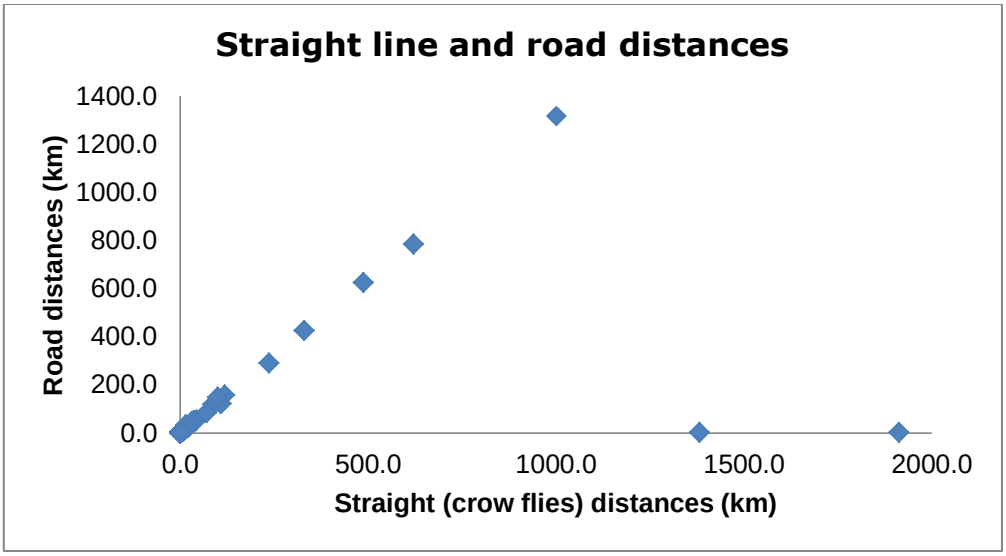
Unlocking stories from the scatter graphs

The data you and your students generated and submitted to the RSSCSE database were for:

A - your/your students' home addresses;
B - the school/college address.

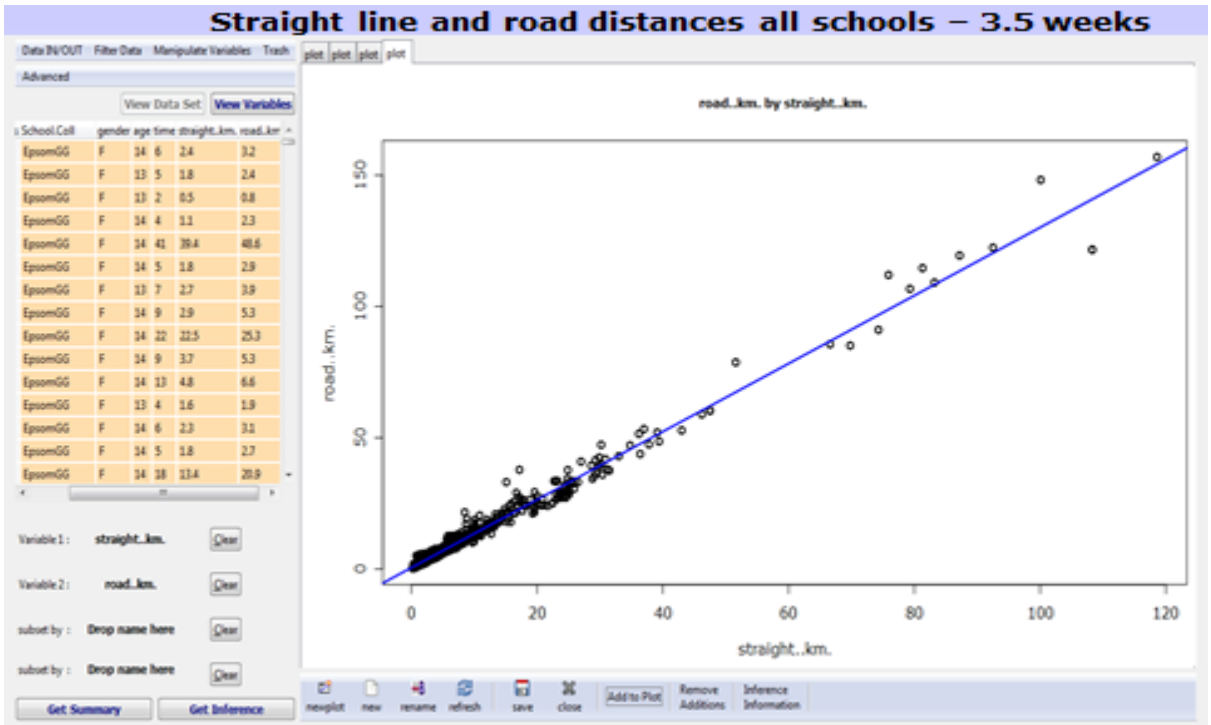
I will discuss how the real data obtained from measuring these distances can be used to explore a range of different concepts in statistics.

At the time of writing over 1200 students from 37 schools had used the distance tool. There were some very large outliers in the data submitted, as can be seen from the scatter graph of the uncleaned database of school-home distances.



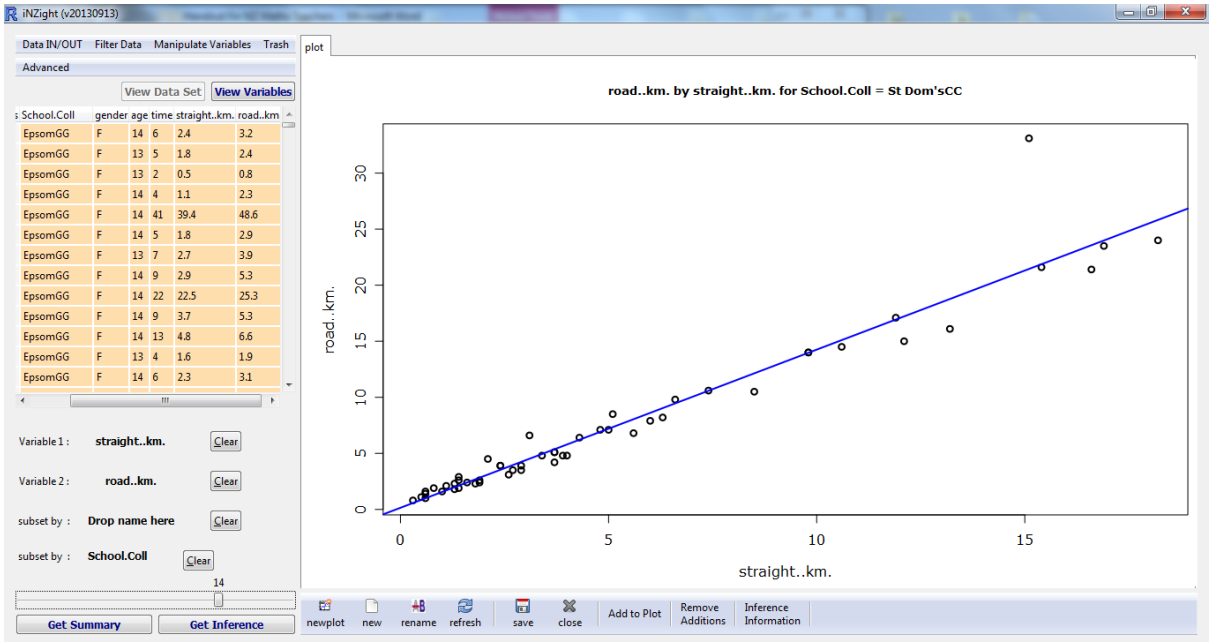
Scrutinising the database demonstrates that students in several schools have quoted their home address as being outside New Zealand - in the USA and Australia. Also, some put their home address within New Zealand, but so far away from their school as to be too far to travel daily. I am told that some schools have students who are boarders, so that the home addresses they entered in the USA, Australia and distant parts of NZ may well be bona-fide, but would influence unduly any analysis for the bulk of the students' data. Another possibility is that the students behaved like students and simply entered fictitious distant home addresses for devilment!

When the very large outliers are removed, the scatter plot still has points that are far from the bulk of the data, but these may be less influential in an analysis. The iNZight plot below contains over 1200 data points, with the extreme outliers removed.



Analysis of distances travelled by students within each school can reveal other features. For example in the following graph of the distances travelled by students at St Dominic's

School, Henderson, one student seems to have to travel much further than would be expected (33.1km), given the straight line distance from home to school (15.1km).

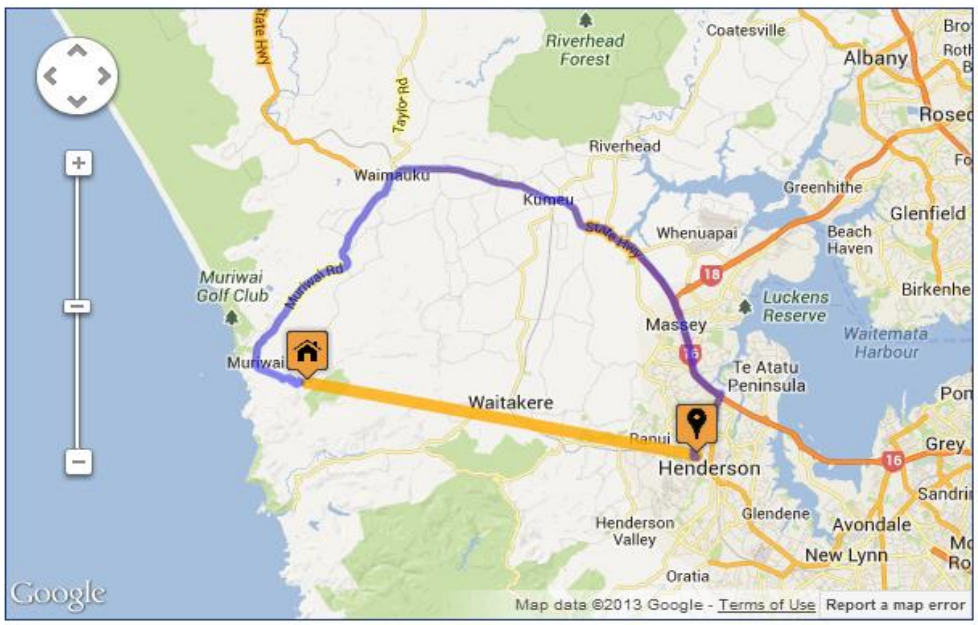


Straight line and road distances St Dom's
(Road = 0.15 +1.41Crow)

The route to school could involve greater distance to be travelled if there is no 'direct' road, for example because of the need to:

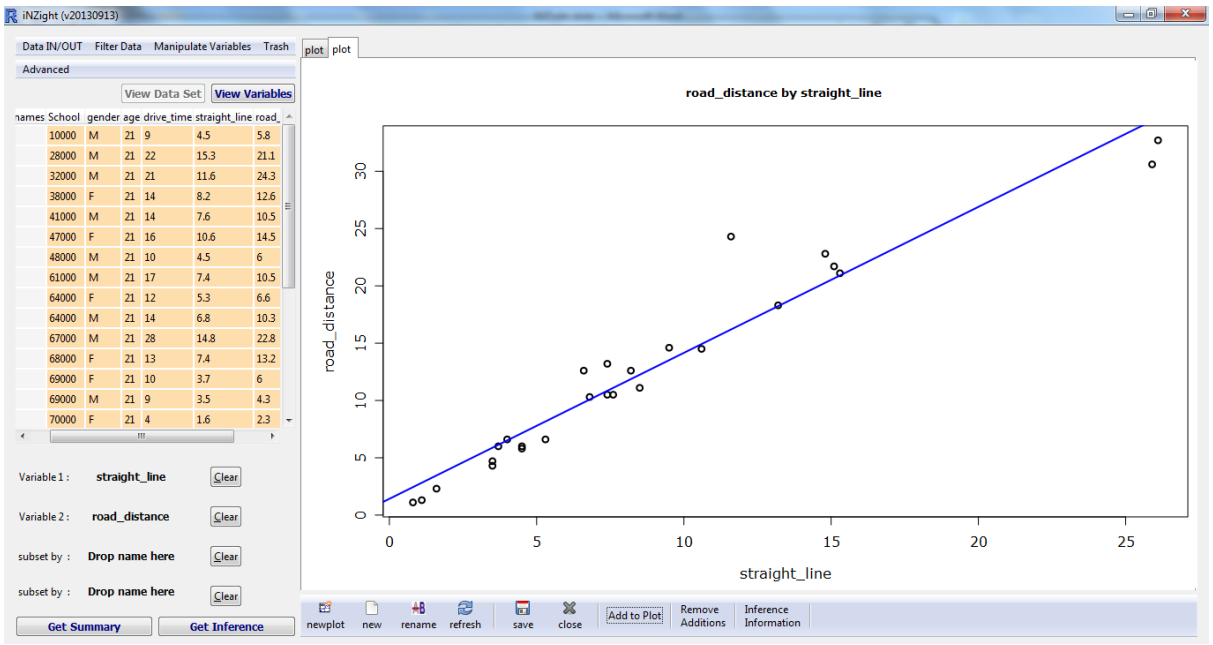
- go around geographical barriers such as hills;
- detour to cross a river by a particular bridge;
- go around a lake or sea inlet.

In fact the St Dominic's student travels from Muriwai to Henderson. The reason for the higher than expected distance is obvious from the map, showing that the extra distance travelled is because of a geographical barrier.



Teachers' travel to school or college

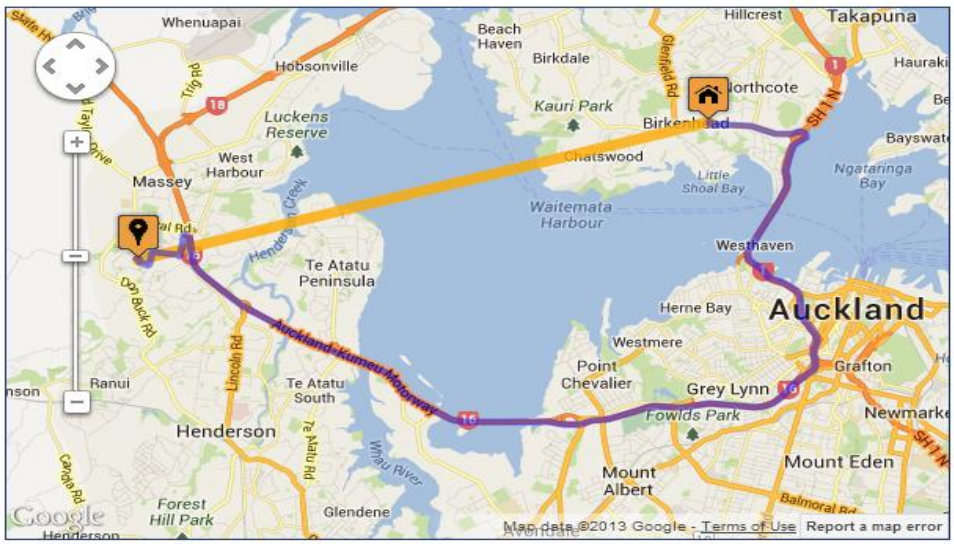
I now look at a sample of 26 teachers (assumed to be those who gave their age as 21 or over) who submitted data. The graph shows the scatter plot and a line of best fit for these data. Note the data point corresponding to a crow flies' distance of 11.6km and road distance of about 24km. The straight line distance is not in itself unusual amongst all straight line distances, but the corresponding road distance appears to be rather higher than one should expect, given the other pairs of distances.



Distances travelled to school by 26 teachers
(Road = 1.41 + 1.27Crow)

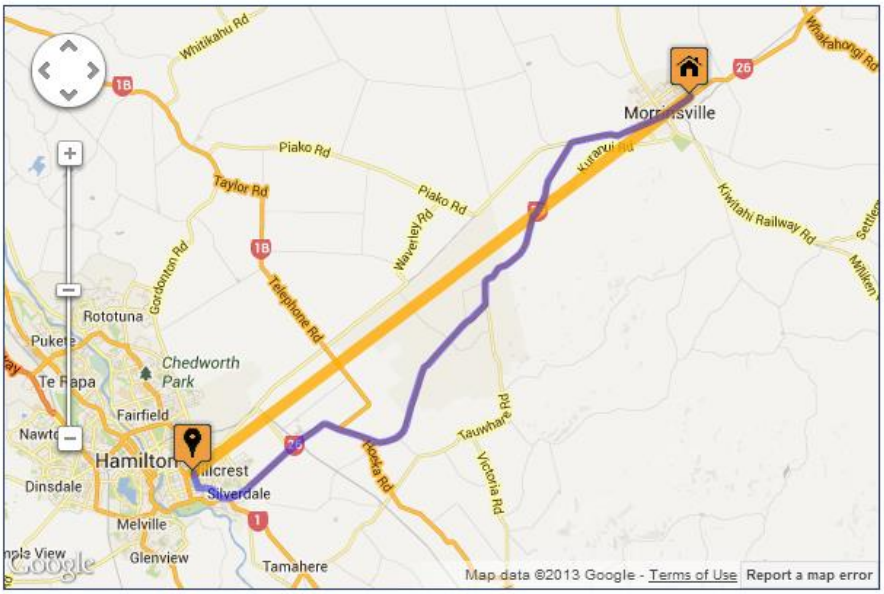
The particular teacher travels from Massey to Northcote College, Birkenhead. The Google distance map shows that Waitemata Harbour needs to be negotiated to be able to travel by road between these points, with the road distance being 24.4km compared with less than half that distance (11.6km) as the crow flies.

I am told by a local that the route chosen by Google involves going through Auckland and so the actual route travelled by the teacher may be through Hobsonville.

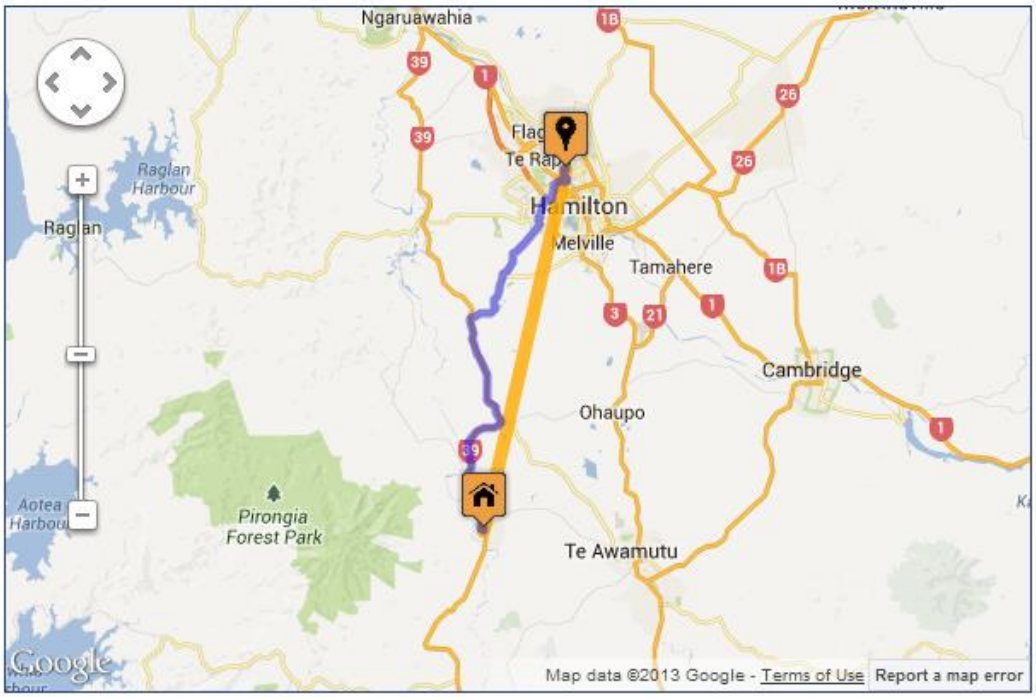


The two points at the top right hand corner of the graph of the distances travelled by school teachers, while not appearing to be outliers relative to the line of best fit, do appear to be influential points.

One teacher travels from Morrinsville to Hamilton East as shown by the next Google map below



and the other teacher travels from Pirongia to Hamilton.



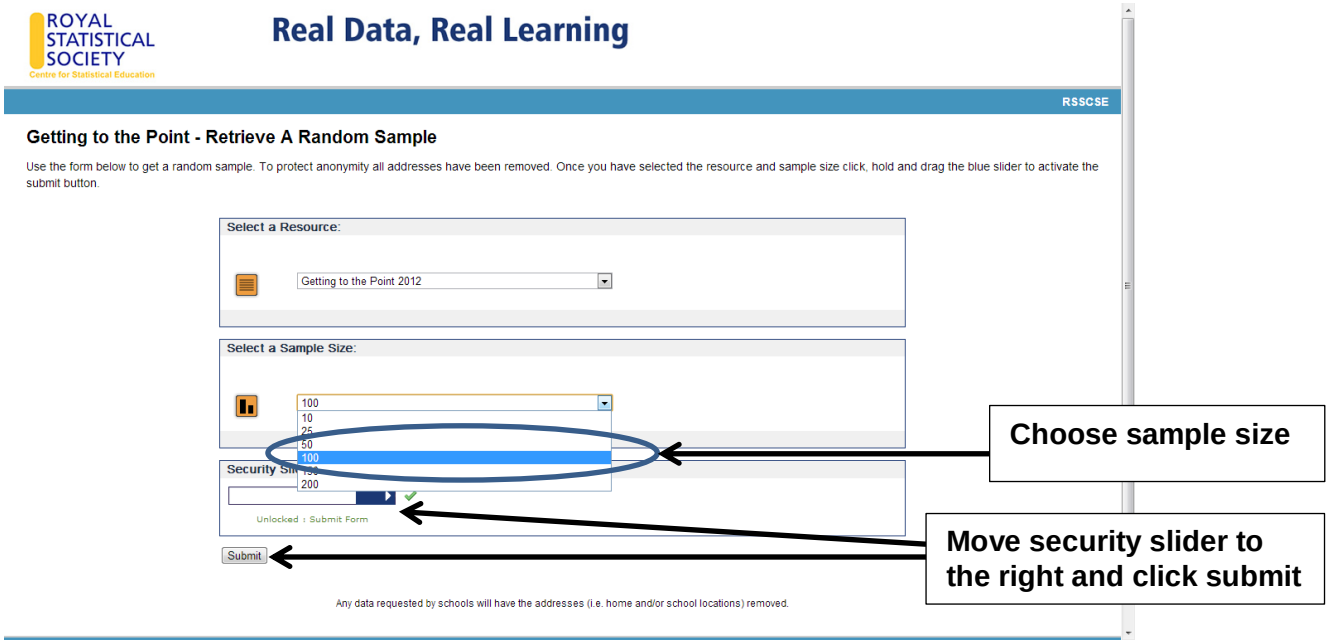
The teachers are on opposite sides of Hamilton, but it so happens that both pairs of distances are similar (25.9km, 30.6km) and (26.1km, 32.6km) but, on average, further from their schools than the other 24 teachers in our sample. There is a 5-minute difference between their average travel times, as estimated by Google maps.

(ii) Retrieving a random sample of distances

You can retrieve a random sample from the data base of all distances by going to

http://www.sportatschool.org.uk/gettingtothepoint/data.php

and completing the data entry window as follows.

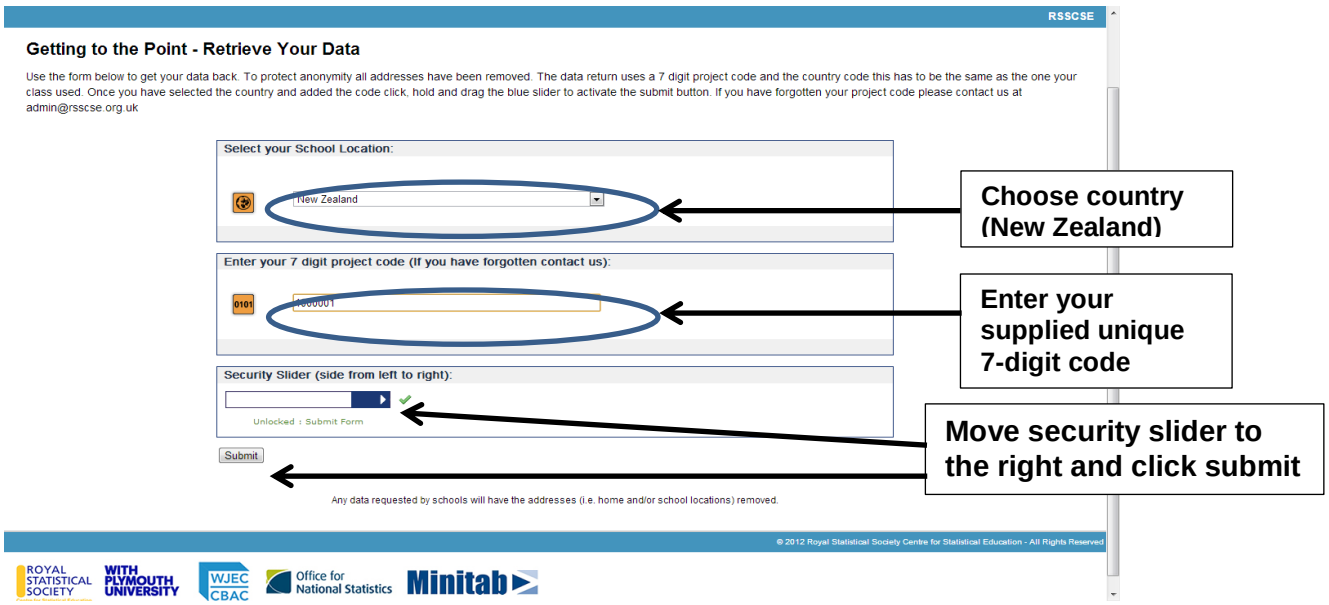


(iii) Retrieving your own school distances

Using the supplied unique 7-digit code you can retrieve all the data submitted by you and your students by going to

http://www.sportatschool.org.uk/gettingtothepoint/getdata.php

and completing the data entry window as follows.



(iv) Further ideas for using the mapping tool in teaching

School profile of travel
By pooling together the travel data for each class, class profiles of home-school travel could be created and in turn an overall travel profile for the school.

Students on Holiday

If point A is the students' home address and point B is their summer holiday address, the distances returned may be very large, especially for those holidays taken outside New Zealand. Analysis would involve discussion of what to do about the (genuine) very large distances: one solution may be to categorise the data into two, such as holidays within NZ and holidays outside NZ, or further categorise by continent/country visited.

Another possibility is to ask the students to enter all the holiday destinations they have ever been to and put together a 'holiday distance profile'. In order to do this a teacher would need to be able to identify each student within the file of data that can be obtained for each school using 1(iii).

Time taken to travel

The mapping tool returns the Google-estimated time to travel over the road distance it calculates. From this the average speed of travel could be calculated for each student's road distance and comparisons made between students.

They could be asked to make a record of the actual time they take to travel to school over say, a week, and comparisons made between the Google time and the average time each student takes to travel to school in a 5-day period.

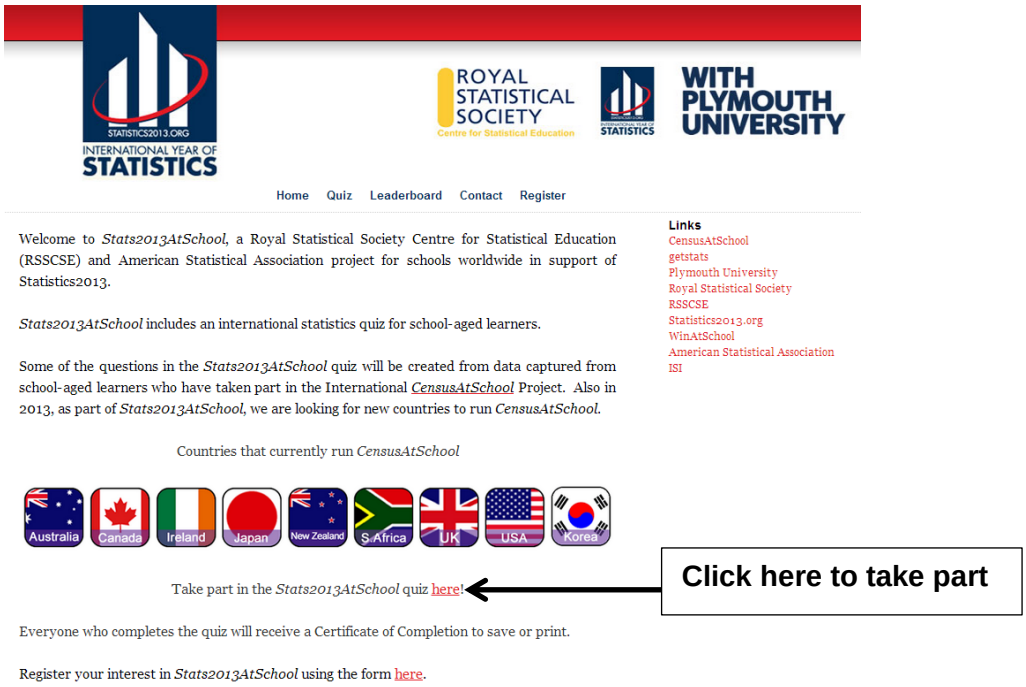
Other investigations

Do females and males differ in terms of distances travelled?
Is there any difference between distances travelled by students of different ages?

2 *Stats2013AtSchool*

World Statistics Quiz

Information about the world quiz can be found at www.stats2013atschool.org.uk
Take part by clicking as indicated below and follow instructions.

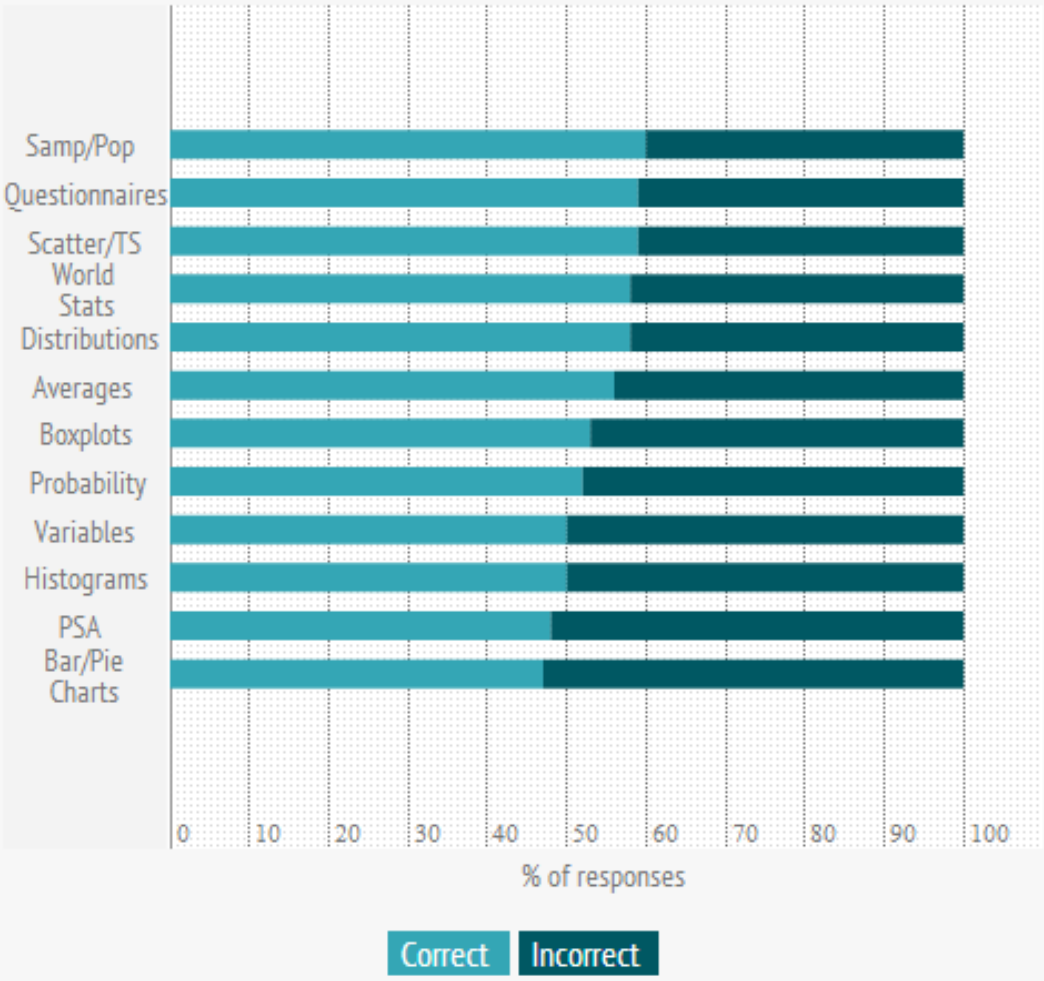


The 12 statistics topics about which the quiz questions are constructed are:

- Problem Solving Approach
- *CensusAtSchool* Questionnaires
- Data & Variables
- Distributions
- Samples and Populations
- Probability
- Bar & Pie Charts
- Boxplots
- Histograms
- Scatter Graphs & Time Series
- Averages
- World Statistics

Note that first topic, Problem Solving Approach (PSA), is another name for the PPDAC cycle used in NZ, also known as the data handling cycle in the UK. The statistics topics that the students who completed the quiz found the hardest and easiest are presented in the following charts. A leader board of students who got full marks in answering the quiz can be viewed at the url www.stats2013atschool.org.uk.

PERCENTAGE OF CORRECT AND INCORRECT RESPONSES BY QUESTION CATEGORY



▲ **1ST - SAMPLES & POPULATIONS**
Correct responses from 60% of pupils

▲ **2ND - QUESTIONNAIRES**
Correct responses from 59% of pupils

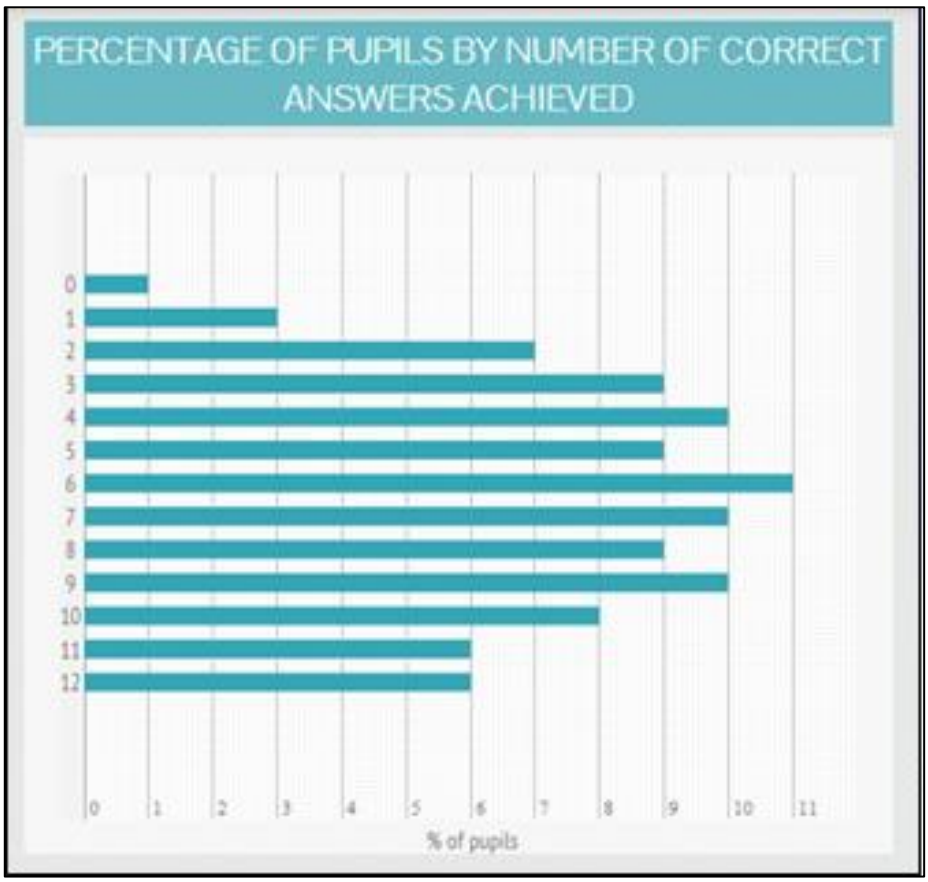
▲ **3RD - SCATTER/TIME SERIES**
Correct responses from 59% of pupils

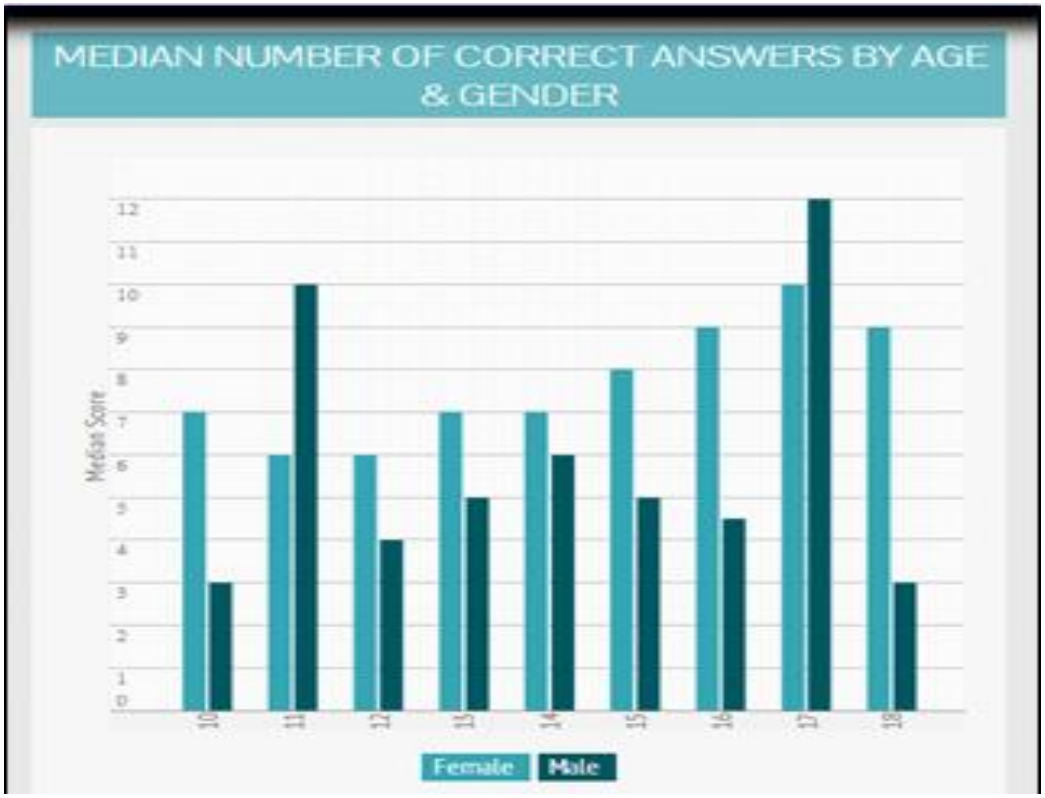
▼ **10TH - HISTOGRAMS**
Correct responses from 50% of pupils

▼ **11TH - PSA**
Correct responses from 48% of pupils

▼ **12TH - BAR/PIE CHARTS**
Correct responses from 47% of pupils


PERCENTAGE OF CORRECT ANSWERS BY CATEGORY AND GENDER (ORDERED BY FEMALE)
Samp/Pop
Questionnaires
World Stats
Scatter/TS
Distributions
Averages
Boxplots
Probability
Variables
Histograms
Bar/Pie Charts
PSA
0 10 20 30 40 50 60 70
% of correct answers
Female
Male
PERCENTAGE OF CORRECT ANSWERS BY CATEGORY AND GENDER (SORTED BY MALE)
Scatter/TS
Samp/Pop
Averages
Distributions
World Stats
Questionnaires
Boxplots
Probability
Histograms
Variables
PSA
Bar/Pie Charts
0 10 20 30 40 50 60 70
Female
Male


PERCENTAGE OF PUPILS BY NUMBER OF CORRECT ANSWERS ACHIEVED
0
1
2
3
4
5
6
7
8
9
10
11
12
0 1 2 3 4 5 6 7 8 9 10 11
% of pupils


MEDIAN NUMBER OF CORRECT ANSWERS BY AGE & GENDER
Median Score
12
11
10
9
8
7
6
5
4
3
2
1
0
10
11
12
13
14
15
16
17
18
Female
Male

3 ExperimentsAtSchool

There are eight simple online experiments, in addition to the distance measuring tool, accessible from **http://tinyurl.com/experimentsnz.** The following table lists the experiments and provides a brief background to each. The data input by students is retrievable as .csv files, The file structure is described in a separate document as series of appendixes.

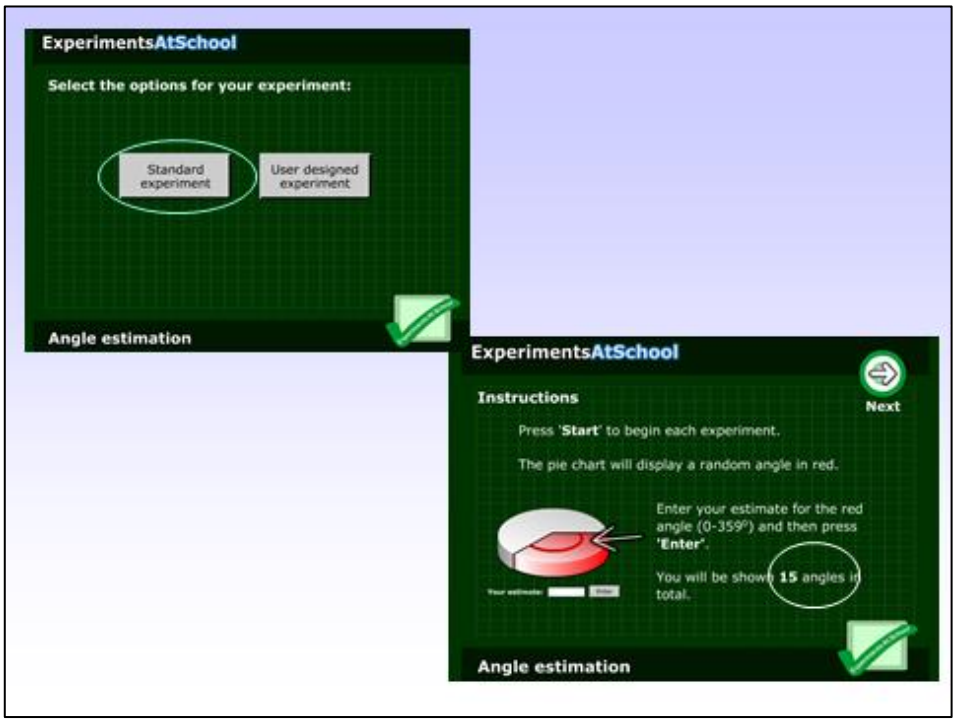
Experiment	Background and Purpose	Appdx
All About Me	Children inherit characteristics or genetic traits from one parent and some from another. Traits include tongue rolling, attached earlobes, freckles and dimples. What traits do you have? How common are they? How many other people have the same combination of traits as you?	1
Angle Estimation	How good are you at guessing angle size in flat and 3-D pie charts? Do you make more errors when estimating a larger angle size than smaller angle size? Are females better than males at guessing angle size?	2
Candle Combustion	When a burning candle is trapped underneath a jar, the candle lasts for a while before going out. Do candles inside larger jars burn for longer? Does the shape of the jar influence the time the candle lasts?	3
Colour Maker	Computer monitors use three primary colours, red, green and blue (RGB). By mixing these three colours in different quantities, a palette of millions of possible colours can be created. In this experiment you will user sliders to mix different amounts of 'RGB' to create the colours of various fruits and vegetables. For example what colour is a banana - how much red, green and blue do you need to mix? Are there big differences in the mixture different people use? What is the 'average' colour people have created for each item of food?	4
Number Estimation	Is it simpler to recognise 5 random dots rather than the 5 regularly placed dots on a dice? Do you make more errors with larger numbers?	5
Optical Illusions	How easily are your eyes fooled? Which optical illusions tend to fool people the most? Does age or gender influence the ability to see through (solve) illusions?	6
Reaction Timer	How quickly can you react? Are you quicker with the hand you normally write with? Do younger people have faster reactions? Do you get quicker with practice?	7
Time Estimation	How good are you at guessing how much time has passed? Do people make more errors when estimating longer or shorter periods of time? Are females better than males at estimating time?	8

In this section I give more detail about the experiments presented in the lecture on 26 November: (I) Angle Estimation; (II) Colour Maker; (III) Number Estimation; and (IV) Optical Illusions.

The input screens and the output you can expect from the experiments: (V) Reaction Timer; (VI) Time Estimation; and (VII) All About Me are also included here.

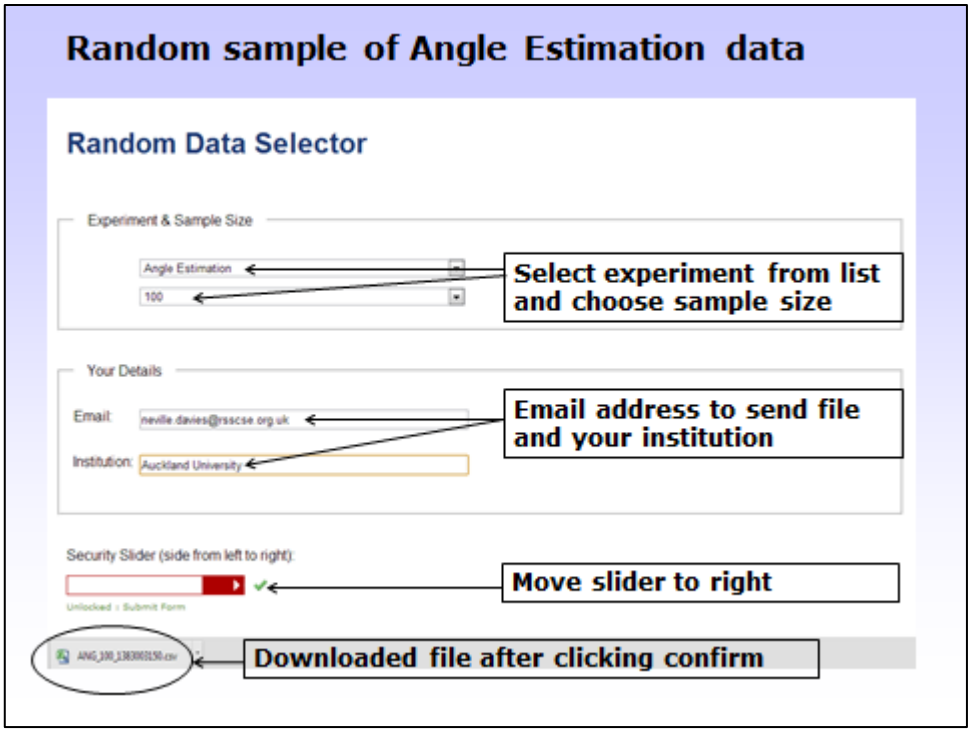
(I) Angle Estimation

There are two options – (i) a standard experiment where all input factors are automatically selected and (ii) a user-defined experiment in which several factors affecting the appearance of the pie charts are controlled by the student.

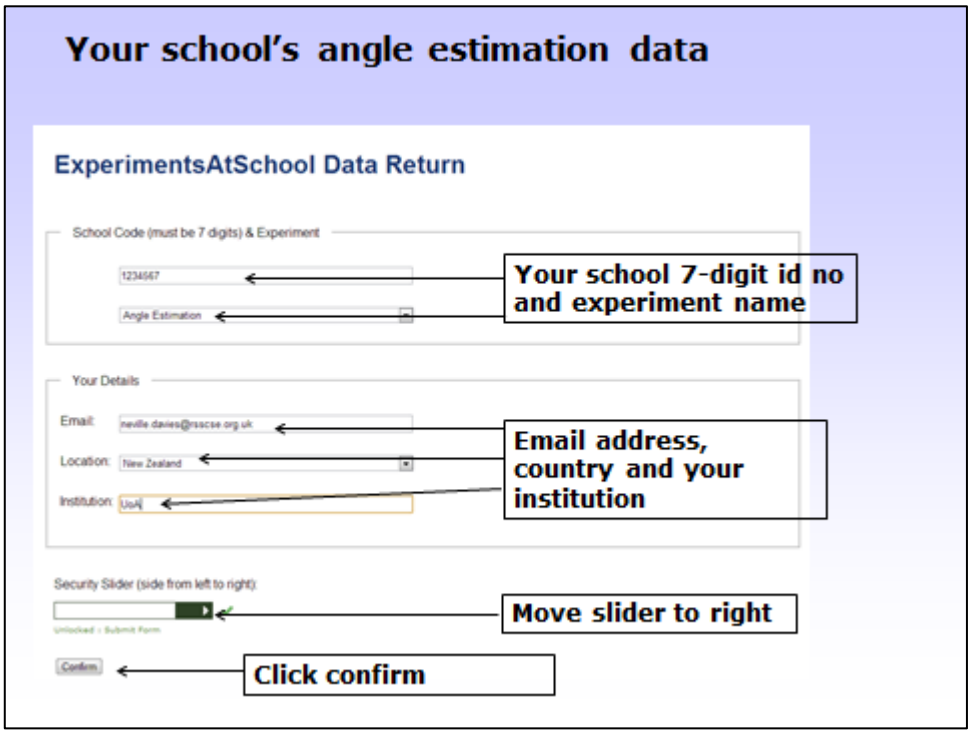


Six typical pie charts from the standard experiment are shown. Students enter their estimates of the angles as shown.

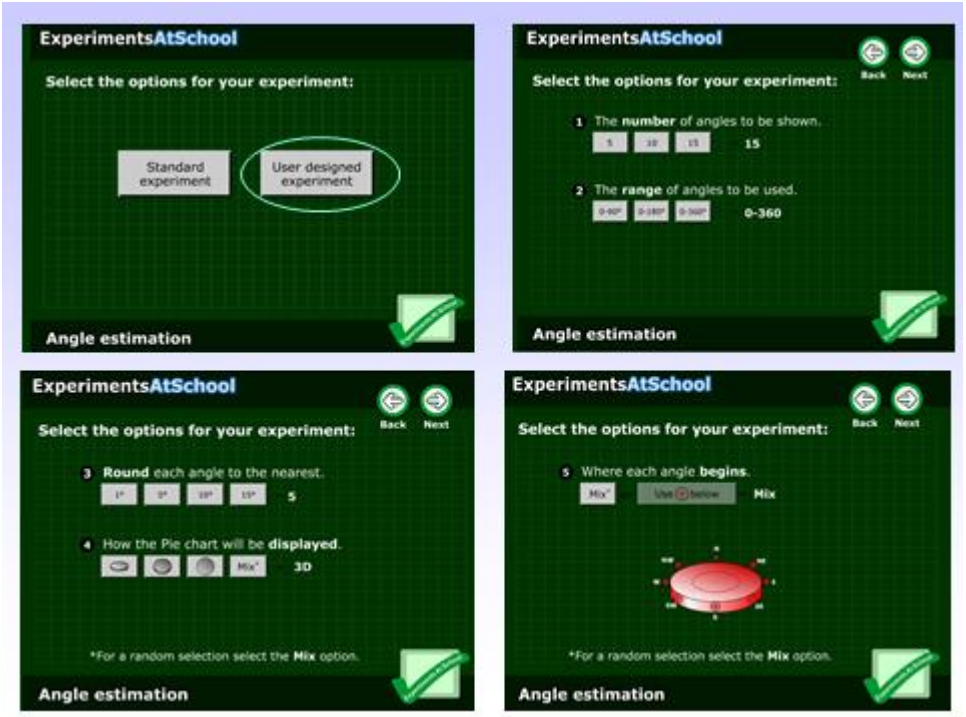
Uploaded angle data can be returned to students using the random data selector with input indicated in the next slide.



You own school's angle estimation data can be obtained as in the following slide



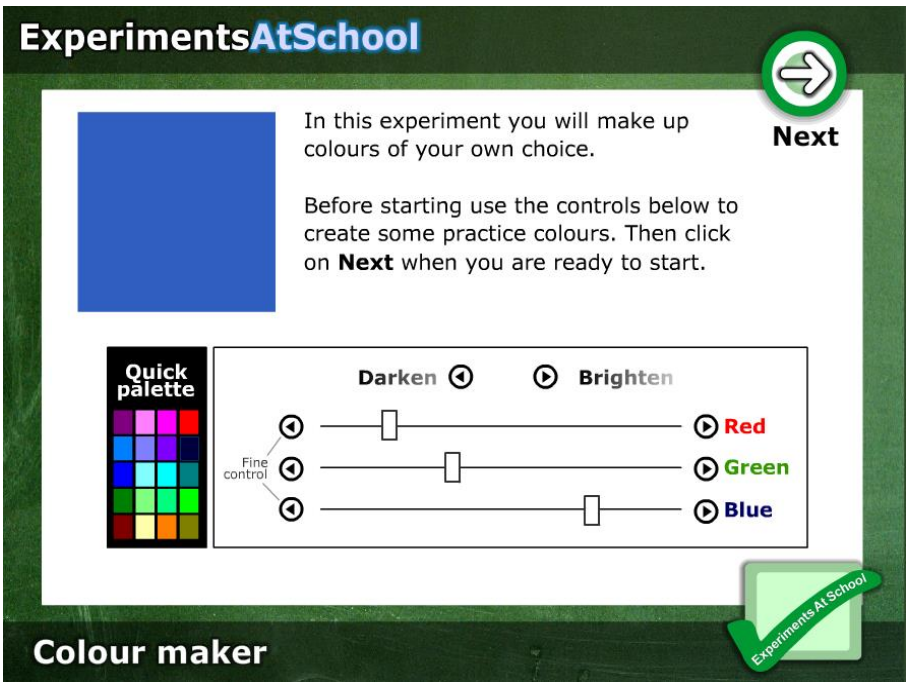
The csv file that is returned to you has a structure as described in **appendix 2**. The options available for a user-defined experiment are given in the next slide.



There are two factors each with three levels, two factors each with four levels and one factor with two levels. Students in a class could be allocated to work in groups on various combinations of factors levels. Graphical approaches can be developed to display the differences between actual and estimated angles between and within factor levels.

(II) Colour Maker

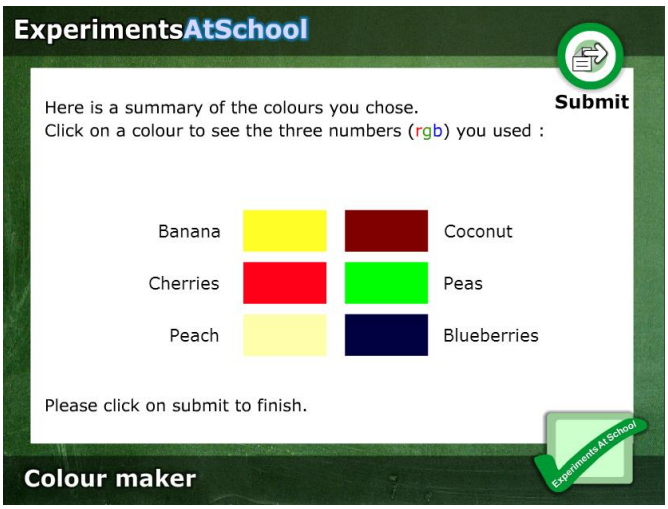
This experiment enables colours to be created on screen using combinations of levels of Red (R), Green (G) and Blue (B), the base palette colours for screen displays.



The sliders alter the display colour in the top left and square.

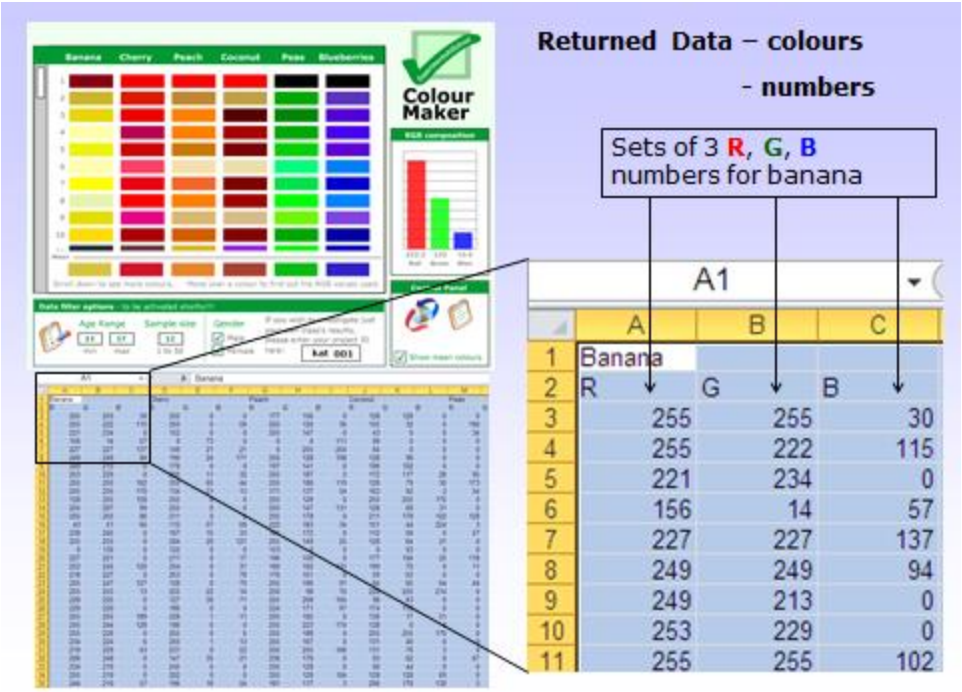
Students are asked to create the colours of 6 common objects, as shown in following six slides.

The summary of the six colours are displayed as in the next slide and the corresponding six triples of R, G and B numbers can be uploaded to the web site by clicking Submit.



The database has the structure given in the following slide. The colours chosen by

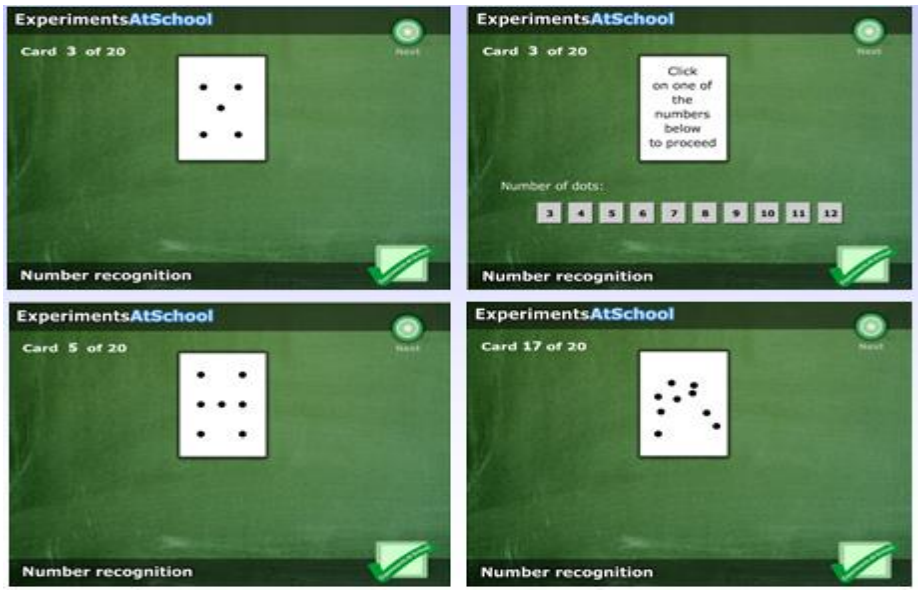
each student are displayed in the top right hand chart, with the corresponding R,G, B numbers below it.



The csv file that is returned to you has a structure as described in **appendix 4**.

(III) Number Estimation

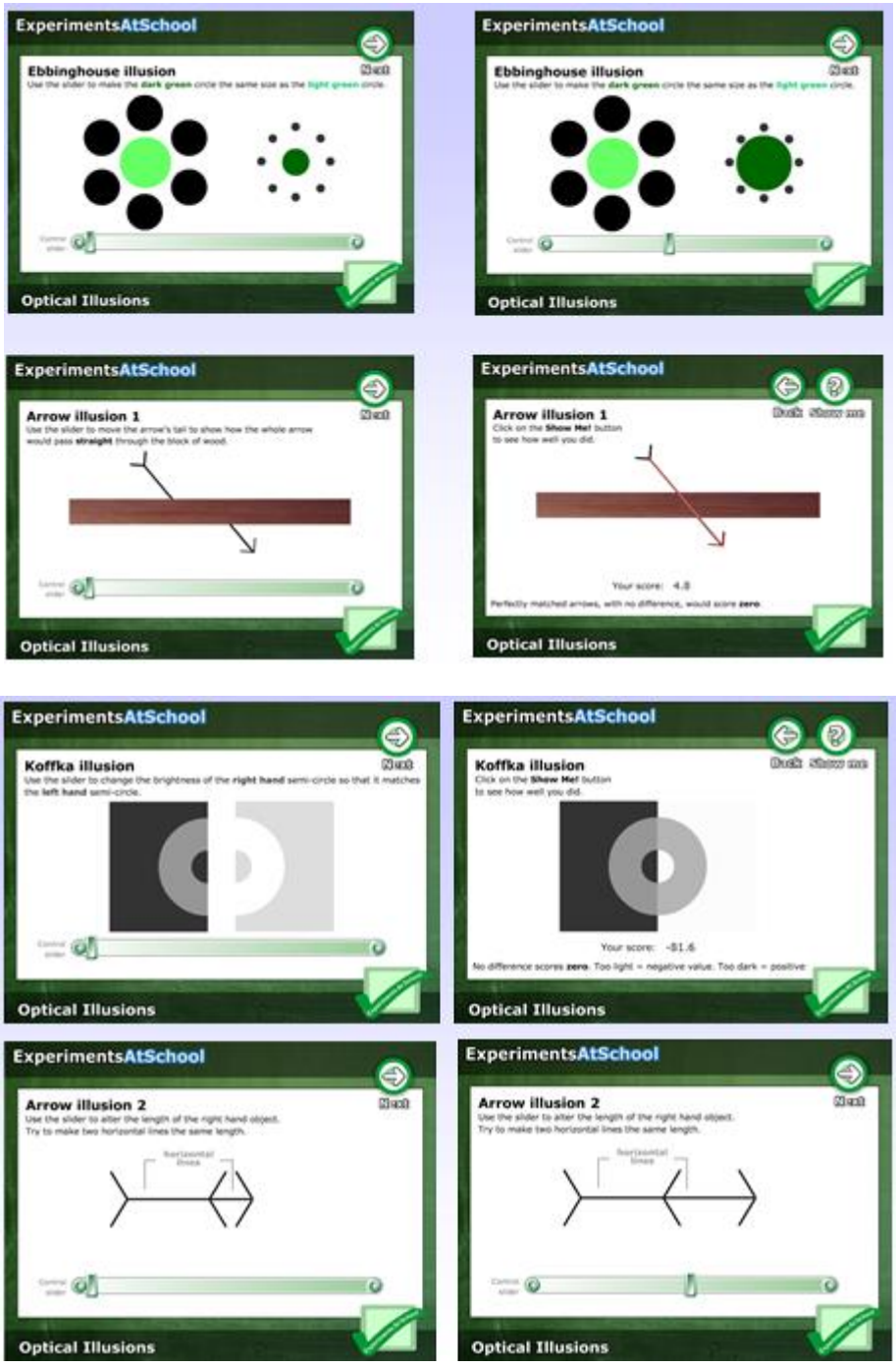
This experiment displays momentarily a number of dots on screen that are either patterned or placed randomly on a white rectangular card. Students are asked to enter the number they think they saw in a subsequent screen. The top two screens in the slide below show a patterned set of dots with the input screen for the estimate of number of dots. The bottom two show another patterned rectangle and a rectangle with randomly placed dots. A total of 20 screens are displayed in the run of each experiment.



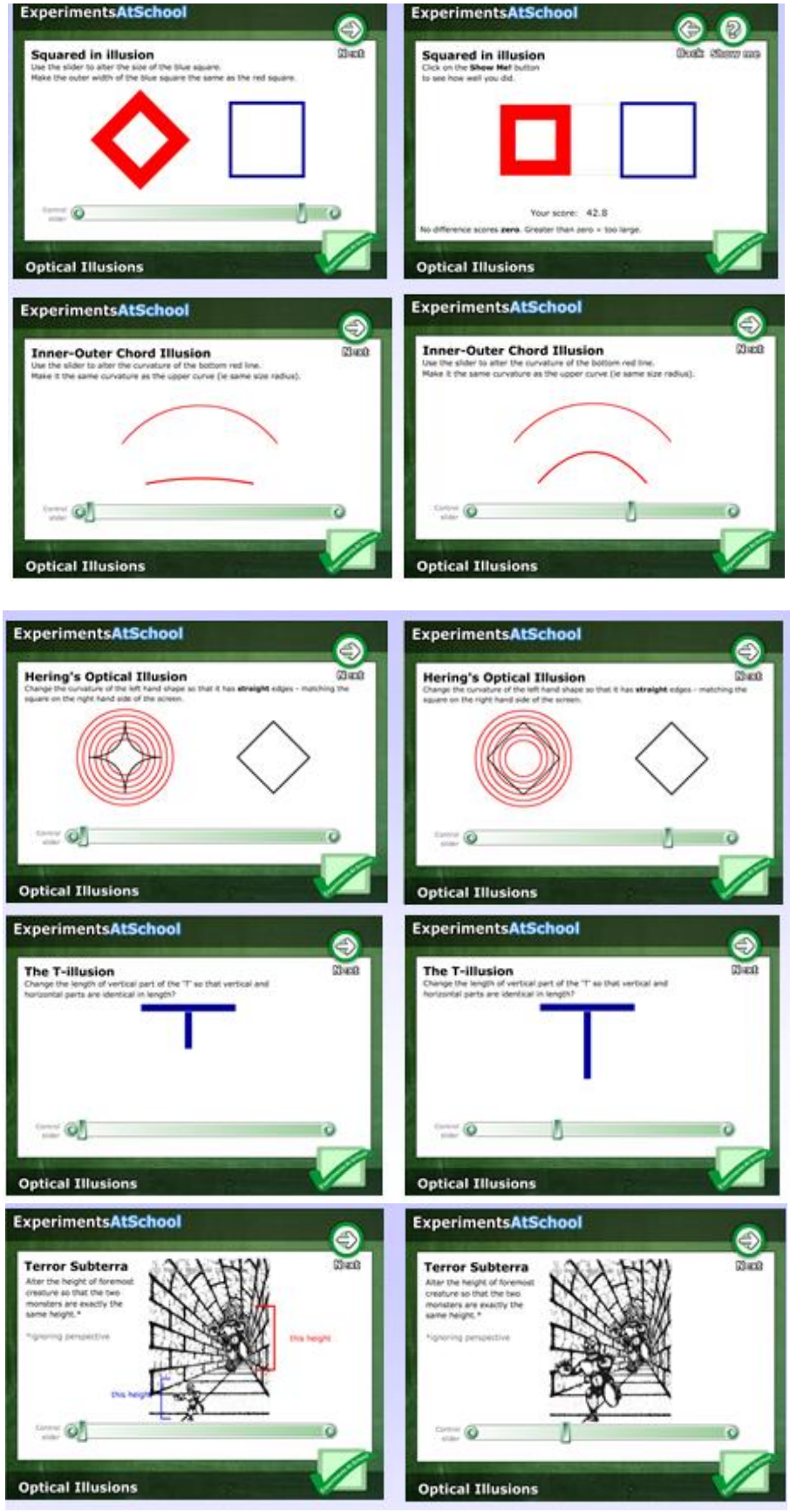
The csv file that is returned to you has a structure as described in **appendix 5**.

(IV) Optical Illusions

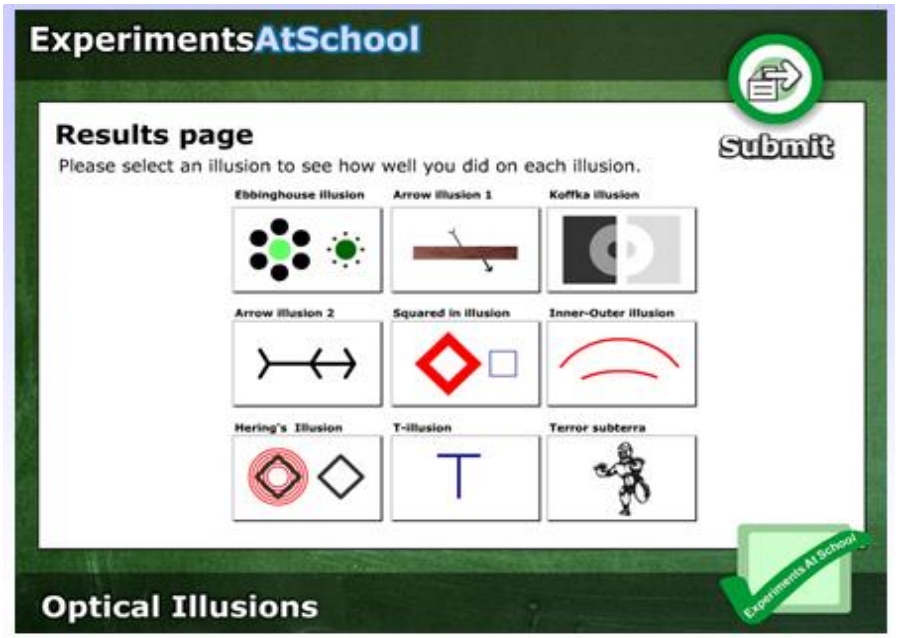
The challenge with these is to move the slider so that a match occurs (i) in circle diameter (Ebbinghouse Illusion); (ii) straight line arrow (Arrow Illusion 1); (iii) grey scale colour (Koffka Illusion); (iv) double headed arrows (Arrow Illusion 2);

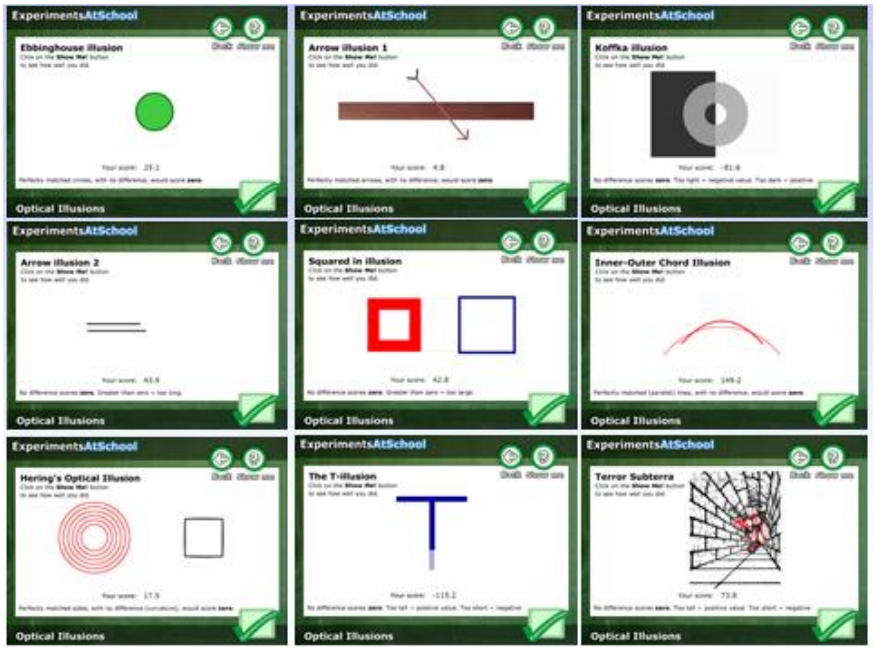


(v) Squares (Squared in Illusion); (vi) arc matching (Inner-Outer Illusion); (vii) square creation (Hering's Optical Illusion); (viii) matching the vertical and horizontal parts of a T (T Illusion); (ix) perspective (Terra-subterra illusion).



A summary of results page is produced with scores for each illusion attempted. How the scores are calculated are given in **appendix 6**.





The csv file that is returned to you has a structure as described in **appendix 6**.

(V) Reaction Timer

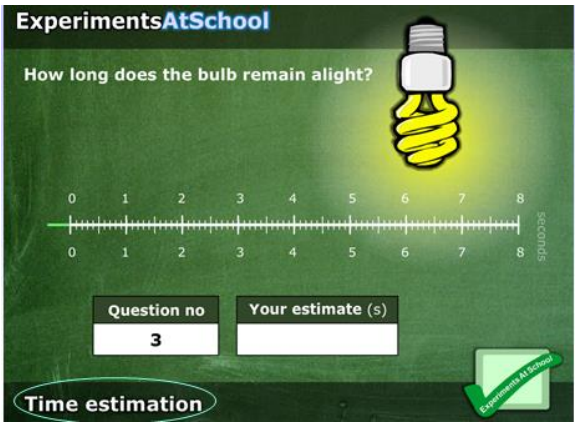
This experiment records you reactions to the appearance of a green light (traffic signal system) and the output enables a comparison to be made between right and left hand reactions, gender differences and whether practice improves reaction times.

The csv file that is returned to you has a structure as described in **appendix 7**.

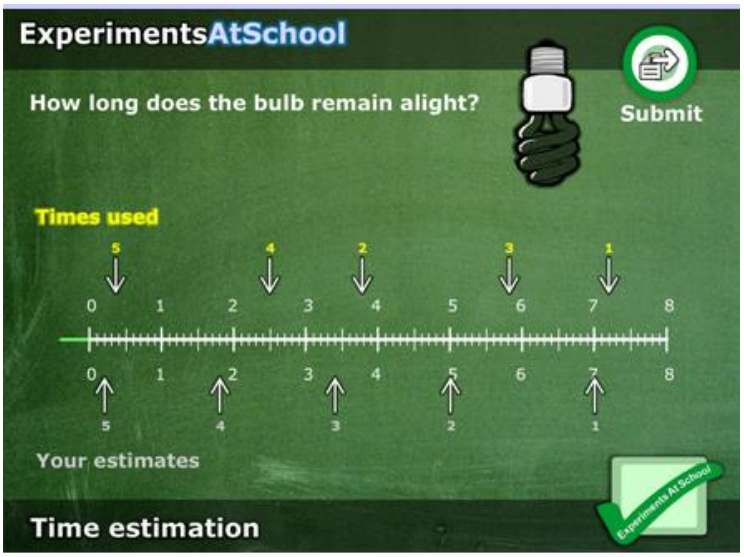
(VI) Time Estimation

This experiment records how well you are at estimating how much time has passed in the appearance of a light staying on. For example, do people make more errors when estimating longer or shorter periods of time?

Are females better than males at estimating time?



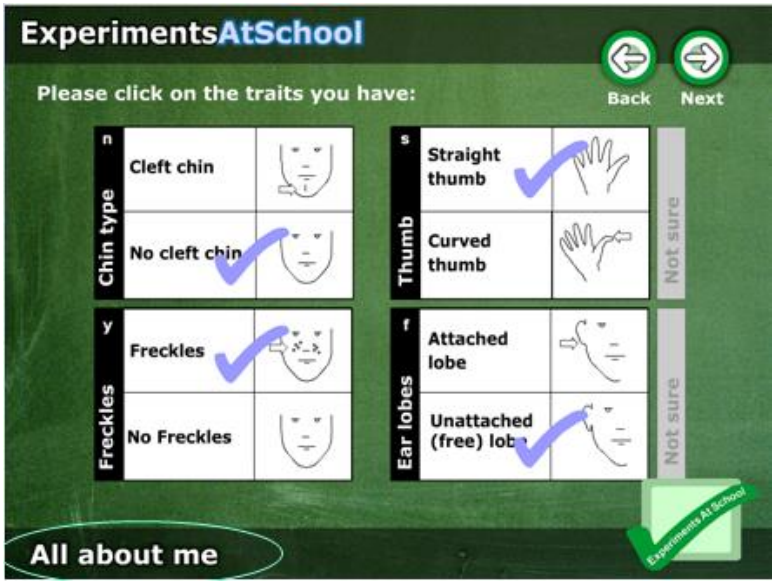
A screen is displayed with the actual time the light was on and the corresponding estimates of the times.

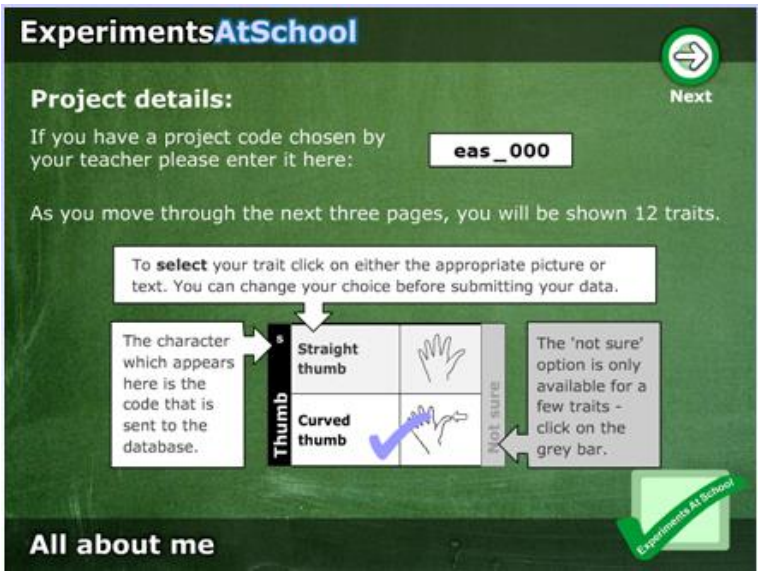


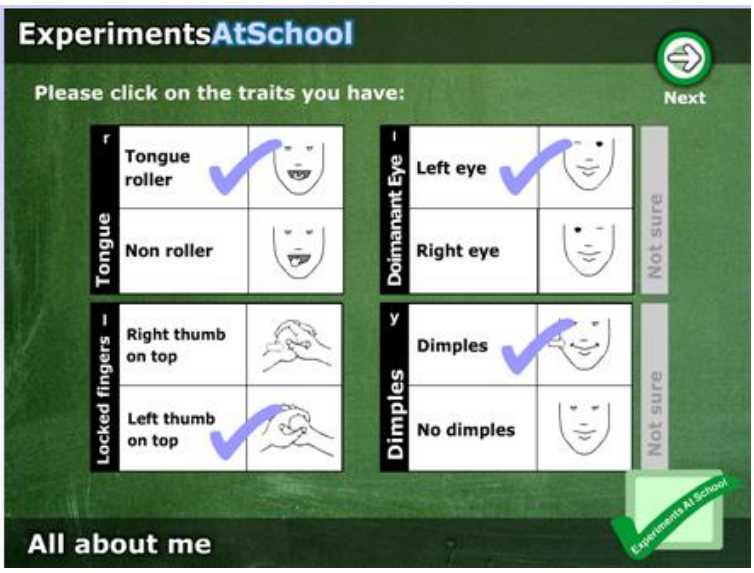
The csv file that is returned to you has a structure as described in **appendix 8**.

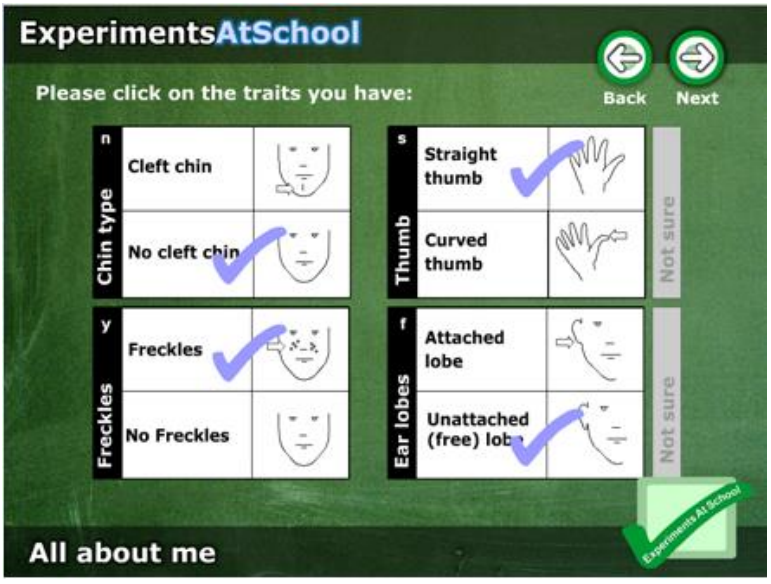
(VII) All About Me

Children inherit characteristics or genetic traits from one parent and some from another. Traits include tongue rolling, attached earlobes, freckles and dimples. What traits do you have? How common are they? How many other people have the same combination of traits as you? This experiment records different traits and enables comparisons to be made within a class and gender differences can be identified.



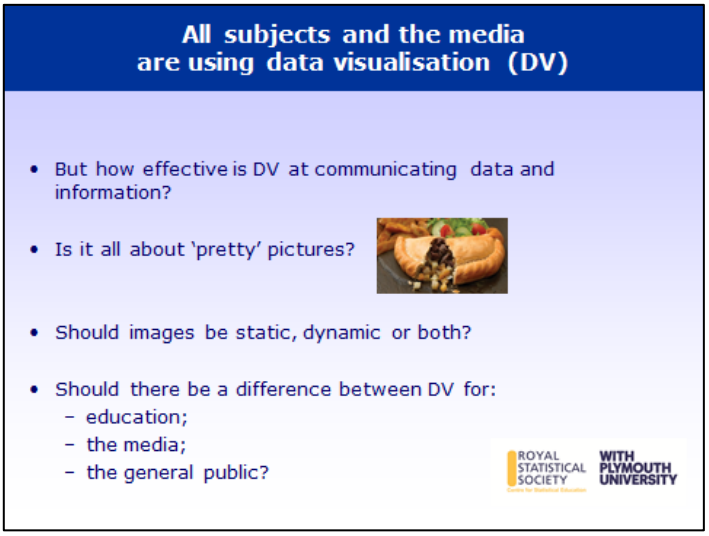

ExperimentsAtSchool
Next
Project details:
If you have a project code chosen by your teacher please enter it here:
eas_000
As you move through the next three pages, you will be shown 12 traits.
To select your trait click on either the appropriate picture or text. You can change your choice before submitting your data.
The character which appears here is the code that is sent to the database.
s
Thumb
Straight thumb
Curved thumb
Not sure
The 'not sure' option is only available for a few traits - click on the grey bar.
All about me

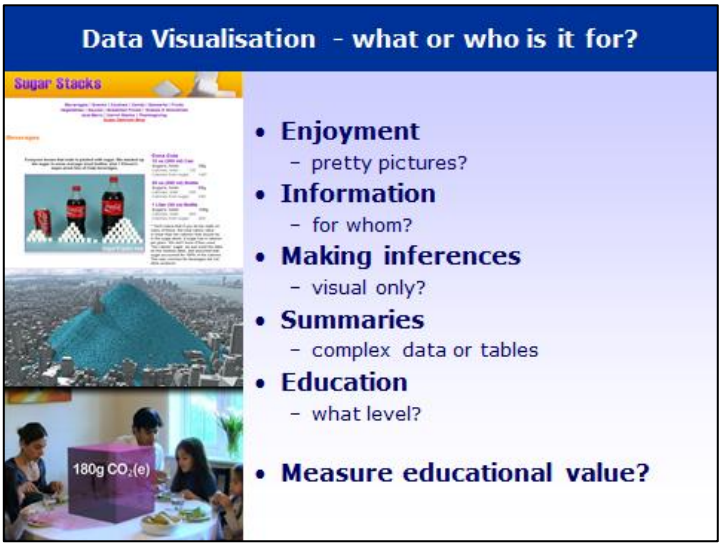

ExperimentsAtSchool
Next
Please click on the traits you have:
r
Tongue
Tongue roller
Non roller
–
Doimanant Eye
Left eye
Right eye
Not sure
–
Locked fingers
Right thumb on top
Left thumb on top
y
Dimples
Dimples
No dimples
Not sure
All about me

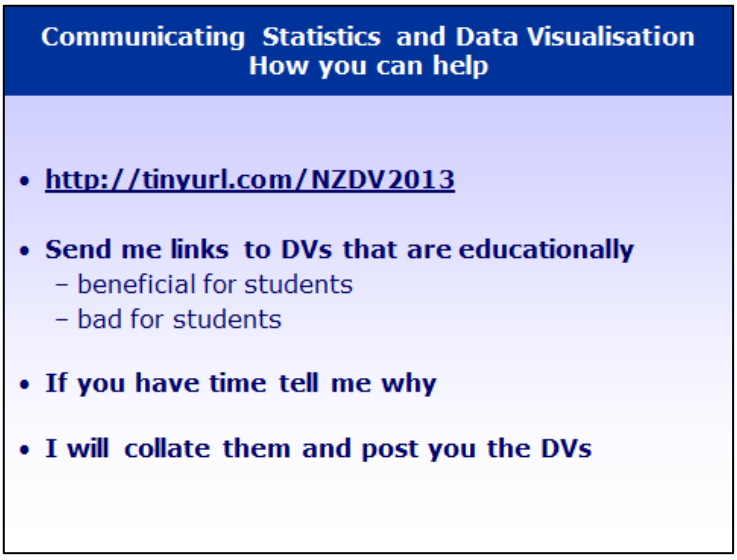

ExperimentsAtSchool
Back
Next
Please click on the traits you have:
n
Chin type
Cleft chin
No cleft chin
s
Thumb
Straight thumb
Curved thumb
Not sure
y
Freckles
Freckles
No Freckles
n
Ear lobes
Attached lobe
Unattached (free) lob
Not sure
All about me

The csv file that is returned to you has a structure as described in **appendix 1**.

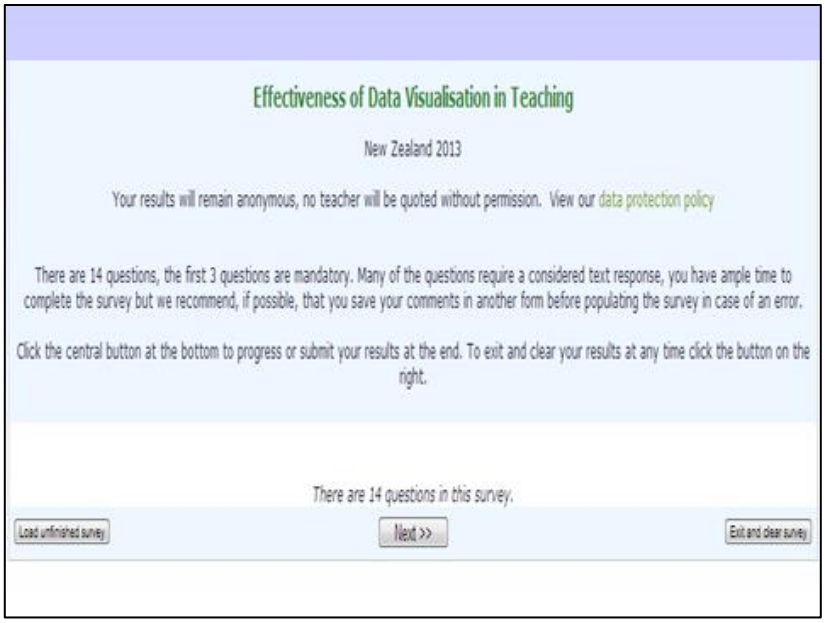
4 Data Visualisation

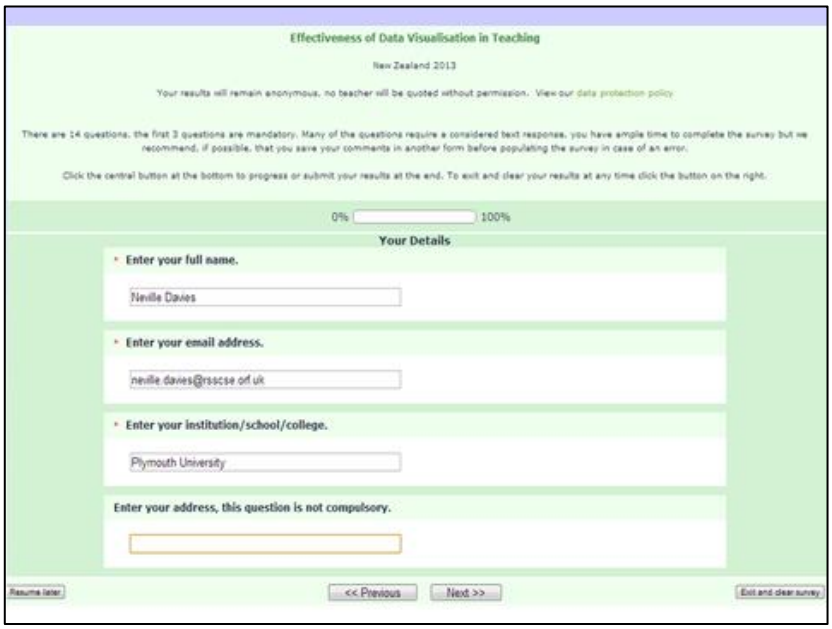




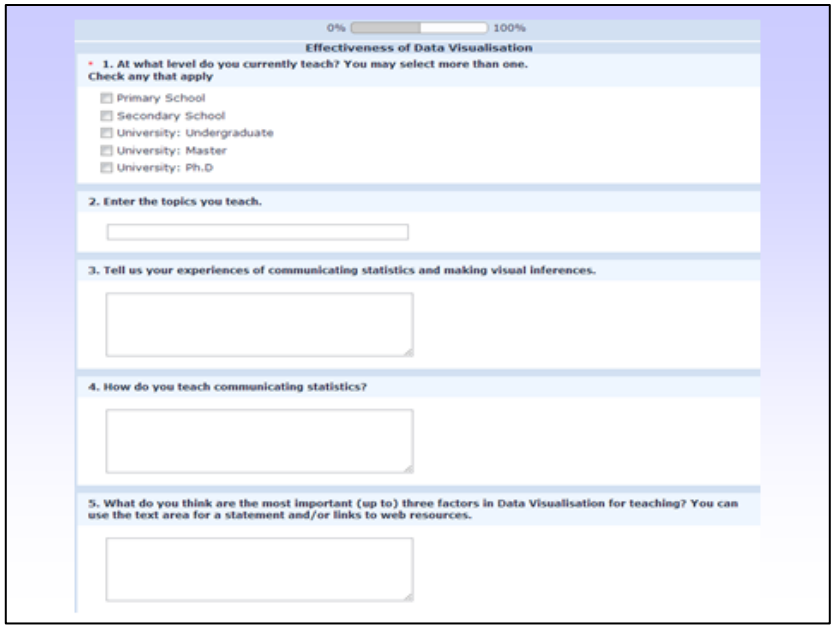


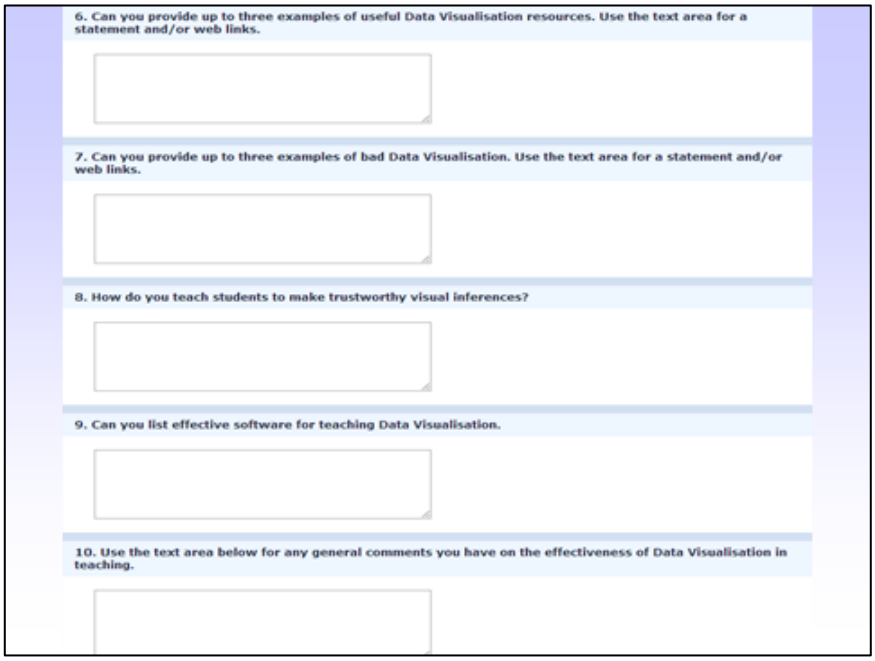
After clicking on **http://tinyurl.com/NZDV2013** the web form appears as follows





The final two screens contain several text input windows inviting you to tell me your views and experiences with data visualisation.





Thank you for your time in reading this document!