Teaching statistics through problem solving: using real time data retrieval.

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In this session

- an approach to engaging students who experience introductory statistics as a service course will be presented.
- a problem solving approach is employed
- the students collect their own data via a real-time classroom survey tool.
- exemplar resources will be introduced
i. Introductory statistics modules

ii. Engaging students

iii. Using a problem solving approach

iv. Implementing real-time survey data collection
What often happens in the first semester

- EDA
- Graphical presentation of data
  - The usual suspects
- Descriptive statistics
  - Location
  - Spread

The rest of the year might include: regression; ANOVA; chi-squared test for contingency tables; ...
Introductory statistics modules

What often happens in the first semester?

- The students have done much of this before
- The students are bored
- They talk among themselves
What do students talk about?

• What are they talking about?
  ➢ Themselves and their friends

• What topics interest them?
  ➢ Their accommodation
  ➢ The neighbourhood they live in/crime

• So– ASK them to talk about these topics in class
Engaging students

- We can use this to get students to learn introductory statistics
- If we use *real* data that is relevant to the students
- If we use a problem solving approach (PSA)
The Statistical Problem Solving Approach

You can build on the first try by continuing here...

First you decide what problem to solve and what data you need.

Have you got all the evidence you want?

Then you collect suitable data.
The first introductory stats lecture

• Introduce the problem
• PLAN
  – Discussion
  – Student questions
  – Choose data
• Reminder of the PSA
What sort of neighbourhood do you live in?
How safe is the area you live in?
How safe do you think it is?
The Problem Solving Approach

You can build on the first try by continuing here...

First we decide what problem to solve and what data we need.

Then we collect suitable data.

Then we examine our data and make it easier to understand.

Discuss

Plan

Collect

Process

Discuss

Plan

Collect

Process
The Problem Solving Approach
How safe is your neighbourhood?

TV, radio and newspapers regularly report crimes and crime statistics.
How safe is your neighbourhood?

Are the crime figures as bad as some of the newspapers suggest?

What are the crime figures like in your neighbourhood?

Are crime figures increasing each year?

Should people be more/less concerned about certain crimes?
Do most freshers live in safe neighbourhoods?

What proportion of students worried about safety?

How can you find out?

Who should you ask?

What should you ask them?
Crime in the Media

Plan

Do freshers choose ‘safe’ neighbourhoods to live in?

Collect

Are students at all worried?

Process

What crimes worry students most?

Discuss

Use a questionnaire?

Is there any association between university town and attitude to safety?
Develop a model of the population.
One variable may depend on another.
Turn the model into precise statistical hypotheses (null and alternative).

$H_0$: There is no association between university town and concern about being mugged

$H_1$: There is an association
The questionnaire

How worried are you about being the victim of the following?

<table>
<thead>
<tr>
<th>Having something stolen</th>
<th>Very worried</th>
<th>Fairly worried</th>
<th>Worried</th>
<th>Not very worried</th>
<th>Not at all worried</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Being mugged or robbed</th>
<th>Very worried</th>
<th>Fairly worried</th>
<th>Worried</th>
<th>Not very worried</th>
<th>Not at all worried</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Being physically attacked</th>
<th>Very worried</th>
<th>Fairly worried</th>
<th>Worried</th>
<th>Not very worried</th>
<th>Not at all worried</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Being insulted or pestered</th>
<th>Very worried</th>
<th>Fairly worried</th>
<th>Worried</th>
<th>Not very worried</th>
<th>Not at all worried</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
The Problem Solving Approach

You are now here.
• The students complete a short questionnaire (online)
• The questionnaire comprises?
  – demographic questions including date of birth
  – questions about accommodation
  – questions taken from the British Crime Survey
    (www.statistics.gov.uk/ssd/surveys/british_crime_survey.asp)
The First Seminar/Workshop
- Collect

Collect student responses in real time

How it works:

a. Member of staff (MoS) enters activation code
b. Students logon using class code and complete questionnaire
c. MoS enters end of class code – deactivates survey
d. RSSCSE server publishes csv file to url
e. Students download csv from url – class continues
f. Next class/workshop do (a) to (e) but NEW (c)
The First Seminar/Workshop – Process and Discuss

- Students revise data summary presentation
  - use their collective seminar data for this
  - summarise their seminar group’s perceptions

- Students draw tentative conclusions
  - limitations of the seminar ‘sample’ discussed
  - possibility of using the whole module group’s responses in next seminar session discussed
You will do this in your first seminars

Students at three other UK universities have completed the questionnaire
The Problem Solving Approach

You are now here.
### Scale of worry: 1 is very worried

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>19</td>
<td>29</td>
<td>27</td>
<td>49</td>
<td>16</td>
<td>140</td>
</tr>
<tr>
<td>B</td>
<td>7</td>
<td>14</td>
<td>15</td>
<td>23</td>
<td>6</td>
<td>65</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>24</td>
<td>13</td>
<td>45</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>45</td>
<td>47</td>
<td>96</td>
<td>35</td>
<td>250</td>
</tr>
</tbody>
</table>

If University and scale of worry are **INDEPENDENT**

\[
P(B \text{ and fairly worried}) = P(B) \times P(2) = \frac{65}{250} \times \frac{45}{250}
\]
<table>
<thead>
<tr>
<th>Scale of worry: 1 is very worried</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>14</td>
<td>15</td>
<td>23</td>
<td>6</td>
<td>65</td>
</tr>
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<td>2</td>
<td>5</td>
<td>24</td>
<td>13</td>
<td>45</td>
</tr>
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<td>45</td>
<td>47</td>
<td>96</td>
<td>35</td>
<td>250</td>
</tr>
</tbody>
</table>

\[
P(B \text{ and 2}) = \frac{65}{250} \times \frac{45}{250} = 0.0468
\]

How does this compare with \( P(B \text{ and 2}) = \frac{14}{250} = 0.0560 \)?

How close are they??
# Expected frequencies

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>19</td>
<td>29</td>
<td>27</td>
<td>49</td>
<td>16</td>
<td>140</td>
</tr>
<tr>
<td>B</td>
<td>7</td>
<td>14</td>
<td>15</td>
<td>23</td>
<td>6</td>
<td>65</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
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<td>24</td>
<td>13</td>
<td>45</td>
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<td>45</td>
<td>47</td>
<td>96</td>
<td>35</td>
<td>250</td>
</tr>
</tbody>
</table>

How many would we have expected to be B and 2?

If B and 2 are *independent*

**Expected frequency** = \( P(B \text{ and } 2) \times \text{(total number)} \)

\[
= \frac{65}{250} \times \frac{45}{250} \times 250 = \frac{65 \times 45}{250} = 11.7
\]

\[
\frac{\text{row total} \times \text{column total}}{\text{overall total}}
\]
Test statistic

\[ X^2 = \sum_{i,j} \frac{(o_{ij} - e_{ij})^2}{e_{ij}} \]

has a chi-squared distribution with \((r-1)(c-1)\) degrees of freedom

\((r-1)(c-1) = rc - r - c + 1\)

number of \(o_{ij}\) frequencies

number of column totals

number of row totals

Remove double counting
The \( \chi^2 \) decision rule

\[
X^2 = \sum_{i,j} \frac{(o_{ij} - e_{ij})^2}{e_{ij}}
\]

If \( o_{ij} \) close to \( e_{ij} \)

\((o_{ij} - e_{ij})^2\) will be close to zero and

\(X^2\) will be small

If \( o_{ij} \) very different from \( e_{ij} \), \((o_{ij} - e_{ij})^2\)

and \(X^2\) will be large

DECISION RULE

Reject \( H_0 \) if \( X^2 \) is too big
Example

H₀: There is no association between university and worry about being mugged

H₁: There is an association

α = 0.05

DECISION RULE

d.f. = (3-1)X(5-1) = 8

Reject H₀ if

\[ X^2_{calc} = \sum_i \frac{(o_{ij} - e_{ij})^2}{e_{ij}} > \chi^2_{0.05,8} = 15.507 \]

From sample data ...
From Minitab

<table>
<thead>
<tr>
<th></th>
<th>m1</th>
<th>m2</th>
<th>m3</th>
<th>m4</th>
<th>m5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19</td>
<td>29</td>
<td>27</td>
<td>49</td>
<td>16</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>15.12</td>
<td>25.20</td>
<td>26.32</td>
<td>53.76</td>
<td>19.60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.996</td>
<td>0.573</td>
<td>0.018</td>
<td>0.421</td>
<td>0.661</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>14</td>
<td>15</td>
<td>23</td>
<td>6</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>7.02</td>
<td>11.70</td>
<td>12.22</td>
<td>24.96</td>
<td>9.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.000</td>
<td>0.452</td>
<td>0.632</td>
<td>0.154</td>
<td>1.056</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>24</td>
<td>13</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>4.86</td>
<td>8.10</td>
<td>8.46</td>
<td>17.28</td>
<td>6.30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.066</td>
<td>4.594</td>
<td>1.415</td>
<td>2.613</td>
<td>7.125</td>
<td></td>
</tr>
<tr>
<td>Total</td>
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<td>250</td>
</tr>
</tbody>
</table>

Chi-Sq = 23.777, DF = 8, P-Value = 0.002

1 cells with expected counts less than 5.
The Problem Solving Approach

Plan

Collect

Process

Discuss

You are now here.
H₀ : there is no association between university attended and fear of being mugged

H₁ : there is an association

α = 0.05

DECISION rule

Reject H₀ if

\[ X^2 = \sum_i \frac{(o_{ij} - e_{ij})^2}{e_{ij}} > 15.507 \]

From sample data

\[ \chi^2_{calc} = 23.777 \]

d.f. = (r-1)X(c-1) = 8

Do not reject

REJECT
What can we conclude?

Other questions?

• about what is this due to
• about other questions/associations
The Problem Solving Approach

You can build on the first try by continuing here...

Plan

Discuss

Collect

Process

You are now here.

Have you got all the evidence you want?
Collect student responses in real time

How it works:

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HOW IS THIS ACHIEVED?
The survey – the student view

http://www.rsscse.org.uk/acc
Student accommodation - How good is yours? (GetStats)

This anonymous questionnaire is designed to discover some important and useful facts about the accommodation that university students use during term time.

There are 19 questions in this survey.

A note on privacy
This survey is anonymous.
The record kept of your survey responses does not contain any identifying information about you unless a specific question in the survey has asked for this. If you have responded to a survey that used an identifying token to allow you to access the survey, you can rest assured that the identifying token is not kept with your responses. It is managed in a separate database, and will only be updated to indicate that you have (or haven't) completed this survey. There is no way of matching identification tokens with survey responses in this survey.
Student accommodation - How good is yours? (GetStats)

Select your university
Choose one of the following answers

Please choose...
- Oxford; University of
- Oxford Brookes University
- Peninsula College of Medicine and Dentistry
- Plymouth; University of
- Portsmouth; University of
- Queen's University Belfast
- Belfast Bible College
- Queen Margaret University; Edinburgh
- Reading; University of
- Henley Business School
- Robert Gordon University; The
- Roehampton University; London
- Royal College of Art; London
- St Andrews; University of
- Salford; University of
- Schiller International University; London
- Sheffield; University of
- Sheffield Hallam University
- Southampton; University of
- Southampton Solent University

Resume later
Student accommodation - How good is yours? (GetStats)

University and Seminar

Select your university
Choose one of the following answers

Please choose...

Course:

BA not-stats

Seminar
Choose one of the following answers

Please choose...

[Exit and clear survey]
Student accommodation - How good is yours? (GetStats)

0% 0 100%

University and Seminar

Select your university
Choose one of the following answers

Plymouth; University of

Course:

BA not-stats

Seminar
Choose one of the following answers

C

Resume later  << Previous  Next >>  [Exit and clear survey]
What is your age in years?

18

What is your gender?

- Female
- Male
- No answer

What year of your course are you on?

Eng1

What is your mode of study?

Choose one of the following answers

- Full time

Please choose...

Your home
Room in a university hall of residence
Room in a university flat
Room in a private rented house
Room in a private rented flat
Private rented bedsit
Rented room in a family home
Other:
No answer
Please choose...
What is your mode of study?

Choose one of the following answers

- Full time

Which of the following areas of study best describes your course?

Choose one of the following answers

- Engineering

Which of the following best describes your term-time accommodation?

Choose one of the following answers

- Your home

How much rent per calendar month do you pay in term time? Give your answer in pounds sterling.

- 320

*Only numbers may be entered in this field*

Indicate any extras that are included in the rent you pay

Choose one of the following answers

- Gas, electricity and water
## Travel

Estimate the distance you travel from your term-time accommodation to your university. Give your answers.

<table>
<thead>
<tr>
<th>Distance Unit</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Either in miles to the nearest tenth (0.1) of a mile</td>
<td>5</td>
</tr>
<tr>
<td>OR in kilometres to the nearest tenth (0.1) of a kilometre</td>
<td></td>
</tr>
</tbody>
</table>

Estimate the total amount of time it takes for you to travel from your term-time accommodation to your first class of the week. Give your answers in minutes.

- 40

For the journey to your university decide which of the following components make up this journey and estimate the total time spent for each type of travel. For any type of travel you do not use on your journey please leave the answer blank. Give your answers in minutes.

<table>
<thead>
<tr>
<th>Mode of Transport</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicycle</td>
<td>5</td>
</tr>
<tr>
<td>Bus/coach</td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td></td>
</tr>
<tr>
<td>Motorbike/scooter/moped</td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td></td>
</tr>
<tr>
<td>Tram</td>
<td></td>
</tr>
<tr>
<td>Metro</td>
<td></td>
</tr>
</tbody>
</table>
Student accommodation - How good is yours? (GetStats)

Quality of life

How would you describe the quality of your accommodation?
Choose one of the following answers

OK

How worried are you about being the victim of the following?

<table>
<thead>
<tr>
<th>Event</th>
<th>Very worried</th>
<th>Fairly worried</th>
<th>Worried</th>
<th>Not very worried</th>
<th>Not at all worried</th>
<th>No answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Having something stolen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Being mugged or robbed</td>
<td></td>
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<td></td>
</tr>
<tr>
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<td>Being insulted or pestered</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is the maximum rent per calendar month you would be prepared to pay for your term-time accommodation? Give your answer in pounds sterling.

350

Only numbers may be entered in this field
What is the *maximum rent* per calendar month you would be prepared to pay for your term-time accommodation? Give your answer in pounds sterling.

350

*Only numbers may be entered in this field*

What is the *maximum time* (in minutes) you would be prepared to spend travelling to university each day?

40

*Only numbers may be entered in this field*

*Estimate the distance from your term-time accommodation to your university as the crow flies* (that is, in a straight line)

*Only numbers may be entered in these fields*

EITHER in miles to the nearest tenth (0.1) of a mile 4.5

OR in kilometres to the nearest tenth (0.1) of a kilometre
Thank you!
Institution: Plymouth; University of

Course: ba not-stats

Survey: Student accommodation - How good is yours? (GetStats)

<table>
<thead>
<tr>
<th>Seminar</th>
<th>Download</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>In progress (<a href="#">check again</a>) [1 result(s)]</td>
</tr>
<tr>
<td>All seminars</td>
<td>Not yet available (<a href="#">check again</a>)</td>
</tr>
</tbody>
</table>
Institution: Plymouth; University of

Course: getstats

Survey: Student accommodation - How good is yours? (GetStats)

<table>
<thead>
<tr>
<th>Seminar</th>
<th>Download</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Download [8 result(s)]</td>
</tr>
<tr>
<td>B</td>
<td>Download [9 result(s)]</td>
</tr>
<tr>
<td>C</td>
<td>Download [5 result(s)]</td>
</tr>
<tr>
<td>All seminars</td>
<td>Download</td>
</tr>
</tbody>
</table>
Institution: Plymouth; University of

Course: getstats

Survey: Student accommodation - Results

<table>
<thead>
<tr>
<th>Seminar</th>
<th>Download</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Download</td>
<td>8 result(s)</td>
</tr>
<tr>
<td>B</td>
<td>Download</td>
<td>9 result(s)</td>
</tr>
<tr>
<td>C</td>
<td>Download</td>
<td>5 result(s)</td>
</tr>
<tr>
<td>All seminars</td>
<td>Download</td>
<td></td>
</tr>
</tbody>
</table>

Opening results-survey31225.csv

You have chosen to open

results-survey31225.csv

which is a: Microsoft Office Excel Comma Separated Values File from: http://www.rsscse.org.uk

What should Firefox do with this file?

- Open with Microsoft Office Excel (default)
- Save File
- Do this automatically for files like this from now on.
<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
</tr>
</thead>
<tbody>
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<td>id</td>
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<td>id</td>
<td>id</td>
<td>id</td>
</tr>
<tr>
<td>2</td>
<td>Seminar</td>
<td>C</td>
<td>41</td>
<td>Male</td>
<td>24</td>
<td>Full time</td>
<td>Computing</td>
<td>Your home</td>
<td>320</td>
<td>Gas, electric</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
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<td>Science</td>
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<td>54</td>
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<td>Science</td>
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Note: The table continues with similar entries.
The survey – the tutor view

LimeSurvey

Username
Password
Language

Login

Forgot your password?
Welcome getstats!
You logged in successfully.
<table>
<thead>
<tr>
<th>Status</th>
<th>Survey ID</th>
<th>Survey</th>
<th>Date created</th>
<th>Owner</th>
<th>Access</th>
<th>Anonymous answers</th>
<th>Full responses</th>
<th>Partial responses</th>
<th>Total responses</th>
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<tbody>
<tr>
<td></td>
<td>31225</td>
<td>Student accommodation - How good is yours? (GetStats)</td>
<td>09.06.2010</td>
<td>admin</td>
<td>Open-access</td>
<td>Yes</td>
<td>24</td>
<td>2</td>
<td>26</td>
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</tbody>
</table>
Title: Student accommodation - How good is yours?

Survey URL (English): http://www.rsscse.org.uk/gary/limesurvey

Description:
Welcome: This anonymous questionnaire is designed to discover some important and useful facts about the accommodation that underpins your long-term time.

Administrator: John Marriott (john.marriott@rsscse.org.uk)
Fax to:
Start date/time: -
Expiry date/time: -
Template: default
Base language: English

Additional languages:
Exit link:

Number of questions/groups: 19/4
Survey currently active: Yes
Survey table name: lime_survey_31225
Hints: Answers to this survey are anonymized.
It is presented group by group.
Participants can save partially finished surveys
No email notification
Response summary

- Full responses: 24
- Incomplete responses: 2
- Total responses: 26

Export Results to Takers
**Institution:** Plymouth; University of

List of courses [from responses so far]

<table>
<thead>
<tr>
<th>Course</th>
<th>#responses</th>
<th>Results</th>
<th>Link</th>
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</thead>
<tbody>
<tr>
<td>A test example</td>
<td>1</td>
<td></td>
<td><a href="http://www.rsscse.org.uk/gary/limesurvey/responses.php?sid=31225&amp;u=126&amp;c=A%5Cntest">http://www.rsscse.org.uk/gary/limesurvey/responses.php?sid=31225&amp;u=126&amp;c=A\ntest</a> example</td>
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</tbody>
</table>
Institution: Plymouth; University of

Course BA not-stats seminar C is now closed.
### Institution:
Plymouth; University of

List of courses [from responses so far]

<table>
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<th>Course</th>
<th>#responses</th>
<th>Results link</th>
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<tr>
<td>A test example</td>
<td>1</td>
<td>[Link](<a href="http://www.rsscse.org.uk/gary/limesurvey/responses.php?sid=31225&amp;u=126&amp;c=A">http://www.rsscse.org.uk/gary/limesurvey/responses.php?sid=31225&amp;u=126&amp;c=A</a> test example)</td>
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</tbody>
</table>
Available from a url
• New project at RSS centre
  – Implementation of real-time responses to classrooms from Lime survey
• What resources are needed?
• What topics
  – Global warming?
  – The environment?
• Do we need subject specific resources?
• ‘Portable’ version being developed
Where now?

- Exemplar resources
  - 3 available
  - PSA PowerPoint template
  - www.rsscse.org.uk
    from the main menu:
    Resources > For Higher Education >
    Teaching Through Problem Solving >
    Workshop Resources
- Additional supporting material?
- More resources needed