



Centre for
Statistical Education

Assessing Statistical Problem Solving

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(RSSCSE)*

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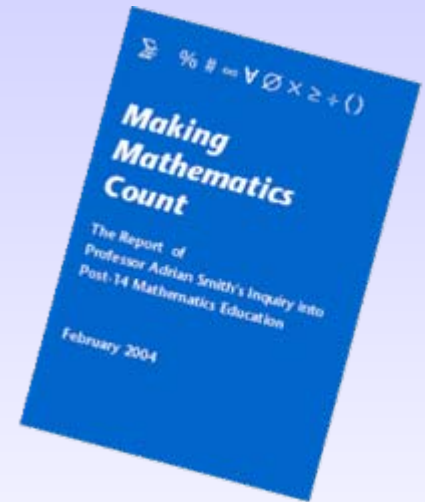
RSSCSE-QCA Project Statistics and Handling data



Adrian Smith's Post-14 Maths Inquiry

recommendation 4.4:

“(i) ...restore more time to the mathematics curriculum ...and (ii) [recognise] the key importance of Statistics and Data Handling as a topic in its own right and the desirability of its integration with other subject areas .”



Review the S&HD content of GCSE Mathematics.

Determine:

- **what should remain core**
- **what may be beneficially seeded through other subjects**



RSSCSE commissioned to do the review (Apr 05 – Dec 06)

Stage 1 (Apr – Dec 05)

- National survey of schools
- 5 recommendations made

Recommendation 1 - The Curriculum

- Stats and handling data should remain in maths but be seeded through real world examples

Recommendation 2 - Assessment

- New ways of assessing the coursework should be trialled. Namely, methods which are time constrained

Recommendation 4 – Teaching Materials

- A range of teaching resources should be developed which teach S&HD through the problem solving approach

Recommendation 5 - Trialling

- Materials developed and trialled through this project were focused on areas of concern arising out of the survey

Further output of the RSSCSE-QCA Project

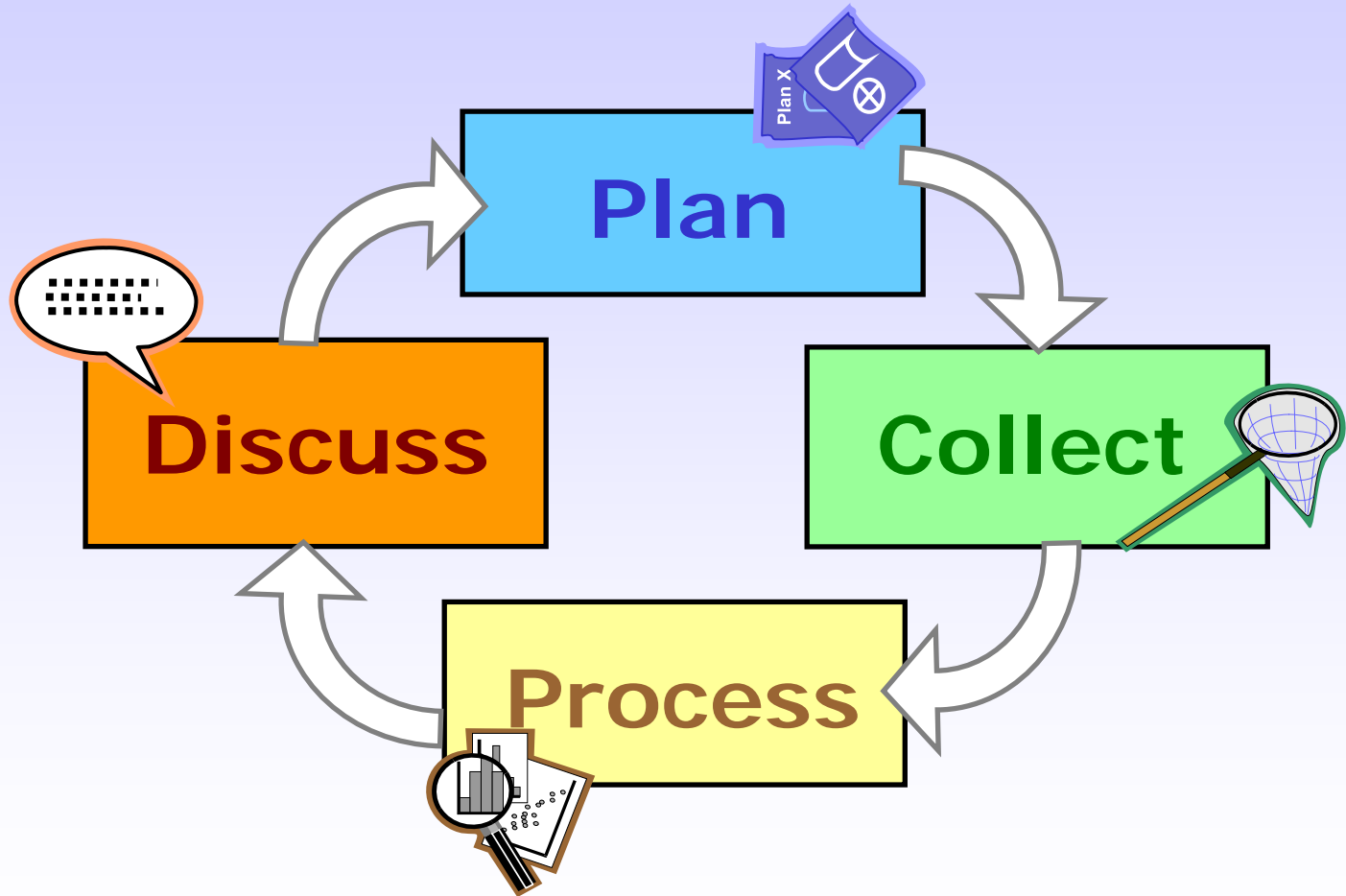
- Stage 2 (Jan – Dec 06)
 - Designing and trialling materials which teach S&HD through problem solving (recs 4&5)
 - After the design and trialling of resources, in December 2006 the RSSCSE made six further recommendations to the QCA...

Recommendation 6 – Future Strategy for Teaching and Learning Statistics

- The QCA should promote the teaching and learning of statistics through the PSA

The statistical problem solving approach

The Problem Solving Approach



Recommendation 10 – Assessment

- The assessment of the PSA should be based on further trials and development of the assessment from this project

Summary of stage 2

- 8 problems and supporting materials (www.rsscse.org.uk/qca)
- Developed a regime for assessing the problem-solving cycle *as a whole*
- We may have produced a way of assessing that part of the curriculum previously tested through the handling data project

Key final recommendations (Dec 2006)

- The QCA should promote the teaching and learning of statistics through a problem solving approach which involves
 - Portfolio of teaching and learning resources
 - Professional development for teachers
 - Development of assessment
 - Dissemination

Assessment features

- Use of the materials for formative assessment
 - questions asked within the discussion and in the pupil worksheets can help assess the pupils' understanding and progress
- Summative assessment
 - coursework no longer part of mathematics assessment in England
- Need to assess understanding of, and skills in using, the psa itself!

The statistical problem solving approach

- Plan
 - Specify the problem and plan
- Collect
 - Collect data from a variety of sources
- Process
 - Process and represent the data
- Discuss
 - Interpret and discuss the results

The Learning Theory

- Anderson and Krathwohl (2001) revised Bloom's Taxonomy, with stages:
 - Understanding
 - Applying
 - Analysing
 - Evaluating
 - creating
- Initial thoughts were that there would be a natural progression through these as the psa evolves

- However, a mapping from the PSA onto the categories of the revised taxonomy revealed that *each* stage of the psa uses at least four levels of the Taxonomy
- The psa clearly provides an 'active learning tool' (Tanner, 2007, JRSS Series A)
- However...
 - "My experience with teachers suggests that they all ignore the 'Marxist-Leninist' 'handling data cycle' - which seems to be a very recent English invention, which is blatantly contradicted by the way coursework is now structured."

Anderson – Krathwohl Taxonomy

Cognitive dimension

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual						
Procedural						
Meta-cognitive						

The Revised Taxonomy and the PSA

Example: Analyze and Procedural knowledge

- **To prepare** a plan for organising and recording the data
- **To determine** an appropriate source(s) for the data
- **To be able** to design data collection sheets appropriate to the variable type
- **To be able** to organise data into appropriate tables/summary

Decisions about the assessment

- Use Taxonomy 'matrix' as basis for ????
- Students placed in role of advisors
 - Tanner (2007) paper on role play
- Students asked to criticize/comment on psa as used by (fictional) peers
- Assessment time constrained
- Core problem(s) should have a familiar context (to young people) to stimulate interest
- Assessment should be online
 - Large data sets can be used
- Assessment should be accessible as possible
 - Audio commentary and zooming could be used

Example assessment

Getting the best deal

Online assessment



Please logon using the code given to you
by your teacher:

Logon

Getting the Best deal (for a mobile phone)

-The assessment context

- The overall scenario concerns the purchase of a mobile phone
 - Three sections of assessment, A, B and C
- Section A
 - Assesses the students understanding of the approach in a holistic way
- Section B
 - Involves a critique of the approach used by an imaginary student called Ayesha who has used the PSA to investigate her mobile phone use.
- Section C
 - Follows an investigation by another imaginary student, Andy, who compares two different 'deals'

Section A – drag and drop



Tasks

The Problem Solving Cycle below has missing labels and descriptions for its four stages.

Below are four descriptions of these stages.
Drag and drop each description below onto the appropriate part of the cycle.

Getting the best deal

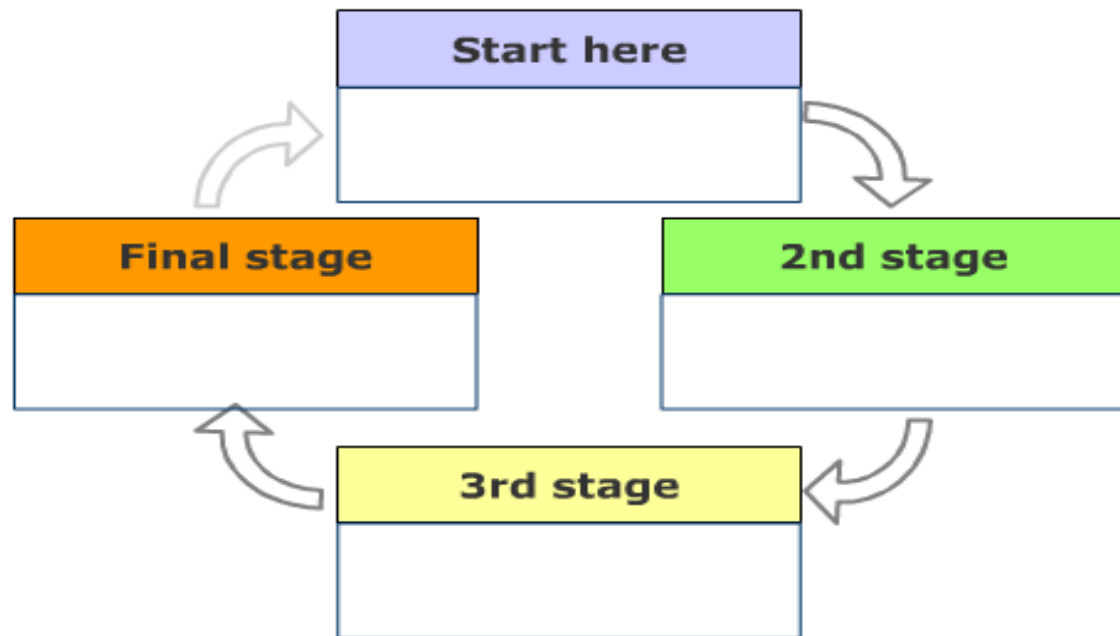


Collect suitable data.

Report back findings – compare it to what was expected.

Decide what problem to solve and what data is needed.

Examine the information and make it easier to understand.



Section B critique a student's approach to solving the problem

- The students to be assessed are presented with a context, a student has used the PSA to try to investigate what mobile phone contract would give her the best value for money.
- The candidates are presented with ten statements that comprise the write up of the investigation
- The questions of this section refer to these statements

Section B – the context



Getting the best deal



Information

Ayesha is in y11. Her parents have paid for her mobile for four years, but now she has to pay for it herself.

She wants to get the best value for money. She remembers that her maths teacher taught her about the **problem solving approach** and how she could use it to solve **any problem**.

She decides to write up her investigations for her GCSE coursework.

Section B – drag and drop



Tasks

Drag and drop each of the statements below, into the correct boxes opposite.

Statement 1

Statement 2

Statement 3

Statement 4

Statement 5

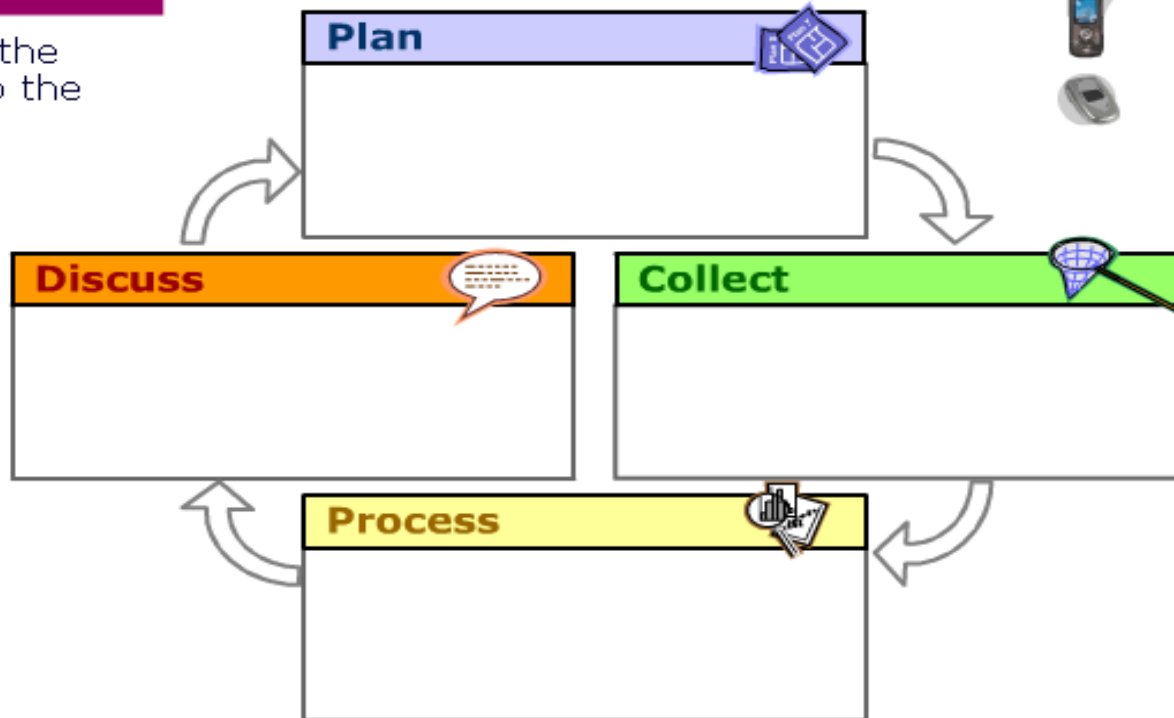
Statement 6

Statement 7

Statement 8

Statement 9

Statement 10



Section B – other questions

- The remainder of this section consists of eight screens
- There are two screens, with questions, for each stage of the PSA
- The questions are about what the fictitious student did
- The questions involve comments, opinions and at times calculations

Section B – a Process stage screen



Getting the best deal



Tasks

Process statements



Using the data I collected I estimated my monthly use:
7 texts a day means I send $7 \times 30 = 210$ texts per month.
27 minutes of calls a day means I use $27 \times 30 = 810$ mins a month.

Using the plan the lady suggested, after 150 free minutes and texts,
I would send 60 texts and use 690 minutes. The total cost is £56

B8. Why did Ayesha use the number 30 in the calculations 7×30 and 27×30 ?

Type in your answer here.

Section B – a Discuss stage screen



Getting the best deal



Tasks

Discuss statements

Although the lady said it would be best, it looks like I would spend more if I had the deal.

£56 is a lot of money. I wonder if I have worked this out right.

B11. Would you advise Ayesha to change to the deal given that the calculations are correct?

Yes

No

Don't know

Why?

Type in your answer here.

Section C – the context

- The students are introduced to a new fictitious student who has a different problem.
- They are invited to help him



QCA-RSS Centre Project: Online Assessment
Version 1.2

Getting the best deal



Information

Andy is in year 11 and is also trying to save money on his phone.

Unlike Ayesha, he started by looking at what deals were available and will then choose which one suits him.

Section C contains questions which ask you to help him do this.

Section C – the questions

Is this slide important?

- Plan
 - Two screens
- Collect
 - One screen
- Process
 - Nine screens including a calculator
- Discuss
 - Two screens
- Plan
 - A final screen of question returns the student to the plan stage in the light of what has been seen

Section C – a Process screen



Tasks

Process



He decides to change the seconds to minutes and round them to the nearest half minute.

C9. Andy has done the first few, can you do the rest shown below?



Day	Day of week	Duration (seconds)	Duration (min)
14	W	193	3
15	Th	33	0.5
16	F	14	0
17	Sa	528	<input type="text"/>
18	Su	1766	<input type="text"/>
19	M	10	<input type="text"/>
20	Tu	20	<input type="text"/>

To use the calculator make sure that it is switched **on**.
Enter numbers by clicking on its buttons (or use your keyboard's numberpad).

If you click away from the calculator it will automatically switch off.

Section C – a Discuss screen

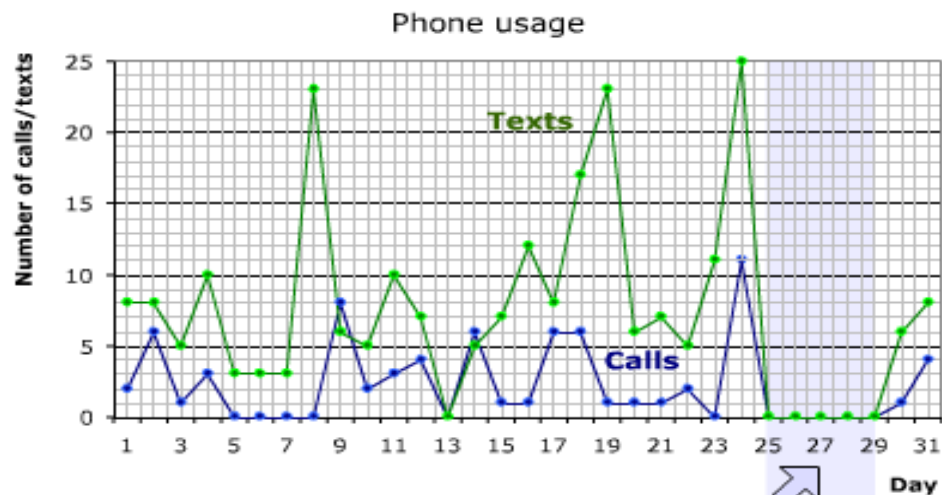


Tasks

Discuss



Andy chose to look at a month of data. He chose the month at random. His teacher looks at his data and sees something interesting. The line graph below shows the number of texts and calls on each day of the month...



C19. Can you give a possible explanation for what happened here?

Type in your answer here.

Section C – return to the Plan stage



Tasks

Plan



C20. Write a plan for an investigation to look at whether it is true that **the more texts a person send, the fewer phone calls they make.**

Type in your answer here.

This is the last question. Only click 'Next' when you have finished.

Section A



Section B



Section C



Time 00:08:07

Screen 44

Back

Next

What happened

- Trialled with two y8 and one y9 group
- Student responses stored in a database
- Marking scheme adapted from the approach used by *Mathematics in Education and Industry* (MEI)
- Five domains:
 - Holistic view of the PSA;
 - The Plan stage;
 - The Collect stage
 - The Process stage
 - The Discuss stage
- Each question scores 1 (correct), 2 (partially correct) or 0 (incorrect)

The Assessment marking

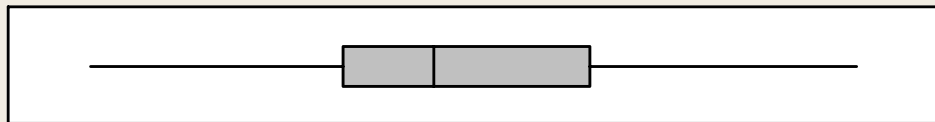
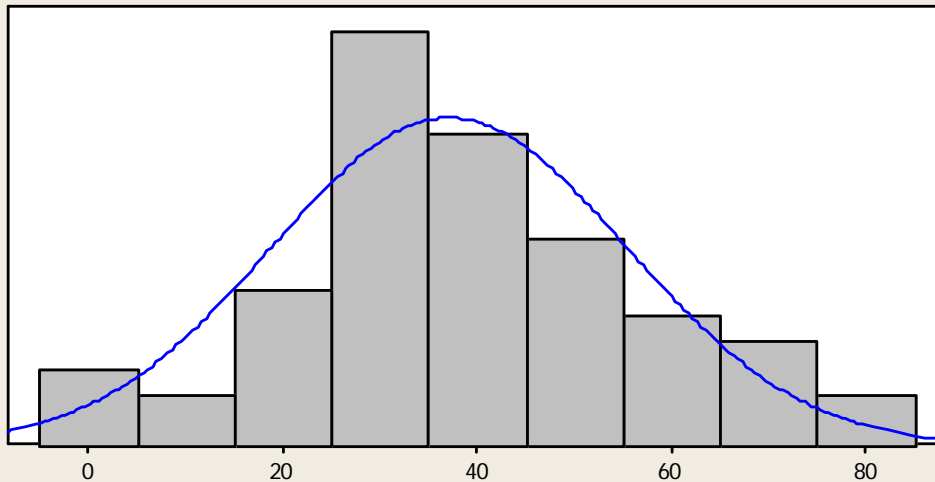
Assessment sheet for *Getting the Best Deal*

Domain	Mark	Question	Description	Comment	Mark
Holistic view	0, 1, 2	A D&D	Places descriptions in correct locations.		
	0, 1, 2	A1	Clear statement of what cycle means and why it is important.		
	0, 1, 2	B D&D	Places statements into correct stages of the cycle.		
Ayesha					
Plan	0, 1, 2	B1 & B2	Gives a clear justification for choice of response to B1		
	0, 1, 2	B3	Correctly identifies the statement that is the problem to be solved.		
	0, 1, 2	B4	Gives a clear description of an alternative method that could be used to choose a day at random.		

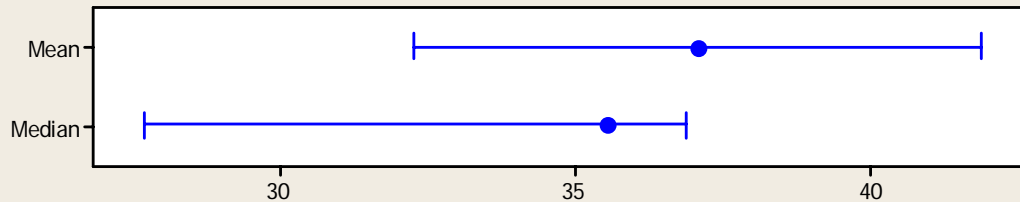
The results – overall performance

- The full range of marks was used

Summary for Total %



95% Confidence Intervals



Anderson-Darling Normality Test

A-Squared	0.64
P-Value	0.090

Mean	37.046
StDev	18.265
Variance	333.613
Skewness	0.295180
Kurtosis	-0.254043
N	58

Minimum	0.000
1st Quartile	25.987
Median	35.526
3rd Quartile	51.645
Maximum	78.947

95% Confidence Interval for Mean	
32.244	41.849

95% Confidence Interval for Median	
27.692	36.842

95% Confidence Interval for StDev	
15.441	22.362

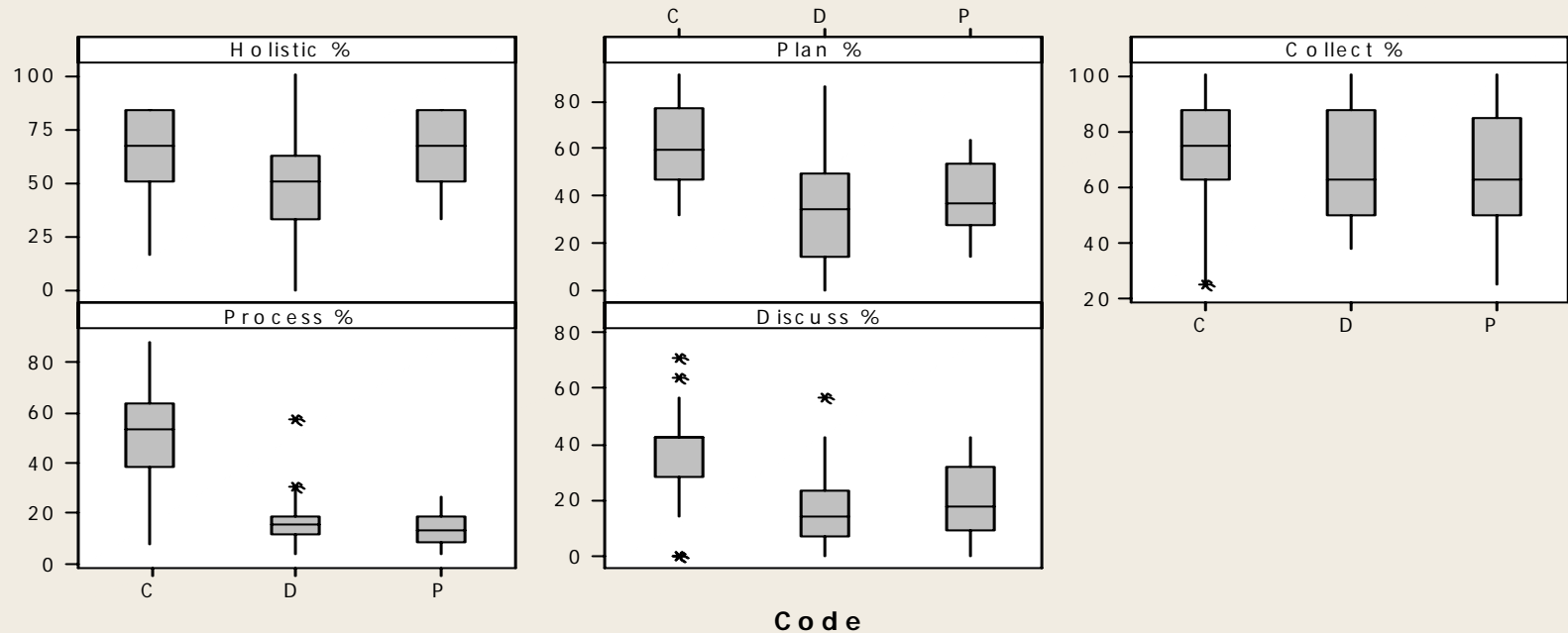
The results – by domain

Domain	N	Minimum	Q1	Median	Q3	Maximum
Holistic	55	0.00	50.00	50.00	83.33	100.00
Plan	56	0.00	27.27	45.45	59.09	90.91
Collect	54	25.00	50.00	68.75	87.50	100.00
Process	55	3.85	11.54	19.23	46.15	88.46
Discuss	54	0.00	12.50	21.43	42.86	71.43

- A wide range of marks observed for each domain
- Poor average performance overall in the 'Process' and 'Discuss' domains

The results – by age of student

Boxplot of Holistic , Plan , Collect , Process , Discuss % vs Code



- C is year nine group, D and P are year 8
- All groups have grasped the idea of the PSA (holistic domain) and performance is similar for the collect domain
- Younger students do less well in other domains

Analysis of different effects

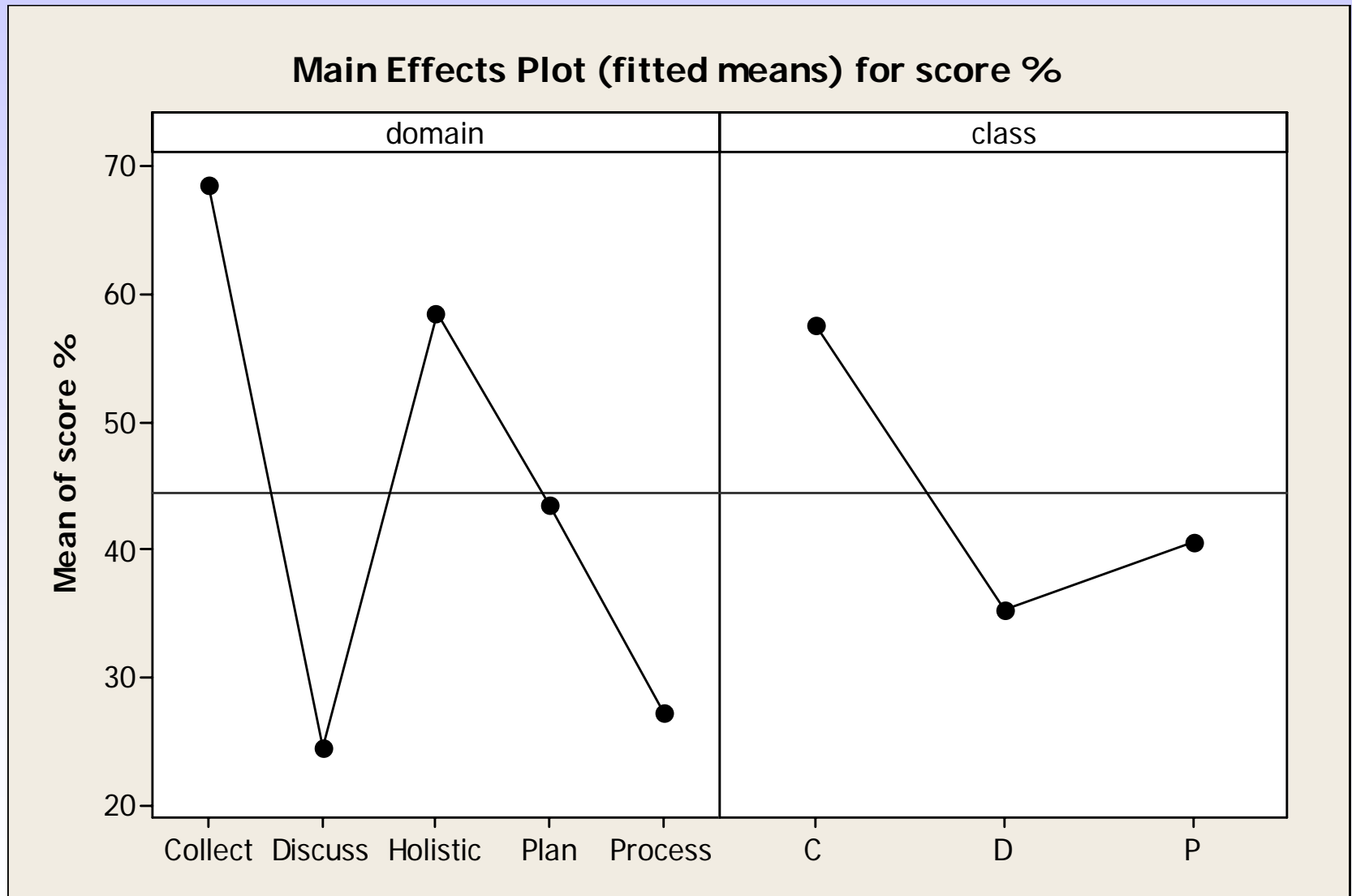
ANOVA

- Two way: class and domain
- Both main effects and interactions were significant ($p < 0.002$)
- Clear evidence of better overall performance by older students

Effect plots show:

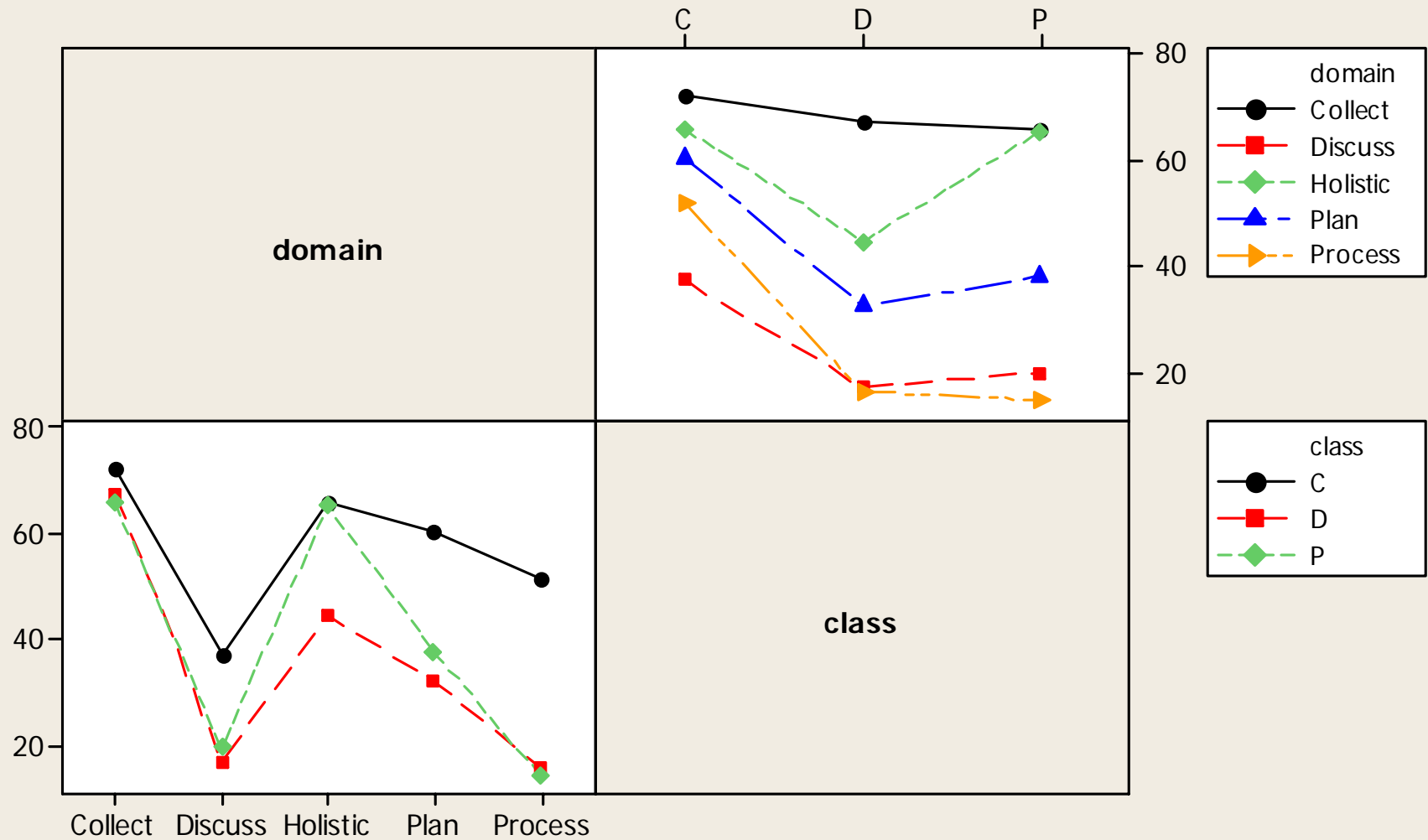
- Poorest overall performance in Process and Discuss domains
- Best overall performance by older students

ANOVA – main effects



ANOVA – interactions

Interaction Plot (fitted means) for score %



Conclusions

- Assessment was well received
- Assessment did assess the PSA as intended
- There is evidence of age related performance
- BUT all students seemed to embrace the holistic view
- Need for an in depth study

THE LAST SLIDE

The End

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