



STATEMENT OF THE PROBLEM

Schools use a lot of paper. There are many reasons why it would be great if we could use less, so our school needs to look at how much paper we use and try to reduce this. To help achieve this goal, investigate our school's use of paper by conducting a 'paper audit.'

PAPER AUDIT – THE STORY

The Planning Stage

This task was carried out with three of our Year 7 classes. We posed the Statement of the Problem to the students, and then in two of the three classes, followed this with initiating a discussion about the kinds of things we would need to look at, to get a full picture of our school's paper usage. This helped shape the key questions which our 'paper audit' would address. We recorded these investigation parameters on the board, which included such suggestions as:

- How much photocopy paper is used at school in a week? A term? A year?
- How much paper are you, as a student, given each week? Each term? Each year?
- What happens to this paper? (eg. Filed, pasted, binned, handed in, lost, returned, given to parents, etc.)
- How much does the paper you use cost?
- How much does the paper the class/school uses cost?

One class actually preceded this brainstorming session with a discussion as to why the topic of 'How do we use photocopy paper?' was an important one, and why their teachers may have chosen it. We used a 'Quality tool' - the 5 Whys - to explore the question, and most of the students' answers related to saving the environment and/or money. The other class (Class 2) did not establish their own key questions through discussion, and students were simply asked these types of questions by the teacher.

Once these matters were established, we then asked the students to consider what we could do with the data, once it had been collected. One group discussed the question of who would be interested in receiving this kind of information and decided that the Principal should receive a report of the investigation.

Authentic Task – Paper Audit

Initially we allocated 1 period per week for this task. This proved to be insufficient and also the regular period we set aside was interrupted by other school activities – sport, course selection, public holiday, etc. In addition, we began the task towards the end of term (last 4 weeks) which was not enough time to allow the project to develop beyond a superficial analysis. However once started, we could see that there were many other opportunities for the investigation.

Doing the Task

Each class progressed in different ways, and achieved different levels of success with their approach (see following reports).

Class 1

Students were able to work alone or in a group of their own choosing. As it turned out, the girls were the only ones to choose group work and some did individual work. Friendship groups were the defining criteria, and we ended up with two groups of 3 and one group of 2. All other students reported individually but often worked in groups or pairs to complete the task.

For the second class spent on the Task, the original teacher was away and so the co-teacher, who had not been present during the initial discussion, provided a worksheet that framed the investigation. Many students were confused about the scope of the task and asked for guidelines, so these were provided to suggest a report format but were kept open-ended (see worksheet 1).

Students decided that we should gather data in several ways:

- A tally of class paper usage for a week – this required a method for tallying and provided the opportunity to demonstrate the method of grouping by 5s with a stroke as the fifth entry.
- Each person's tally was consolidated onto a class tally for the week and copied for each person as raw data.
- A count of the paper stocks in the photocopy room and a recount some days later (this was different for different students).
- Individual investigations of how paper is used, how much paper weighs, how many trees are required for paper use- etc. These questions developed from individuals and the information was shared in the class.



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The report format provided challenges for most students – they were engaged in the enquiry but found reporting detail difficult to develop without constant support and guidance.

The notion of explaining how they found information, the steps they went through and the mathematics involved was a constant source of nagging. Most students wanted to report on results and recommendations rather than process, and while many scraps of ‘working out’ existed, students had to be instructed to ‘Show me the Maths’ as part of a final report (the assessment task).

One lesson per week was timetabled in the computer room. This provided an opportunity for students to use spreadsheets to record data and generate graphs. Most chose to do this rather than draw graphs by hand (this was a problem in assessing student understanding – verbally they could describe the data, but when it came to written interpretation of the graphs many students did not do this.) It also meant that students did not have to do the computations or partitioning needed to produce graphs – yet it is a “modern” method of producing graphs and the students saw no need to do otherwise.

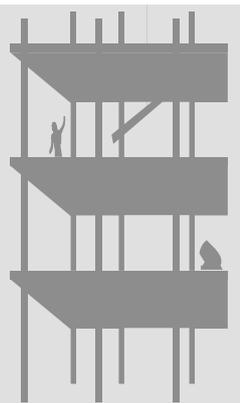
More time to discuss what the graphs actually mean would have been helpful.

An assessment rubric (see rubric) had been provided to the class for a task earlier in the year and this was revisited (and redistributed) a week before the report was due. Students were asked to bring a draft of their report and in pairs evaluated their work against the rubric – making suggestions for improvement. While this process is essential, it was hampered by lack of time for discussion and attention to individual cases.

- A model report (one of the drafts from a student) was demonstrated as a way, not the way the report could be presented - its strengths and shortfalls were explained and students were given another four lessons to finalise their reports. The principal also attended this class and students reported verbally to him, describing their processes and findings. He valued their work and their data and promised to consider their results.

Strategies for paper-saving that students came up with, are presented below:

- Put recycle bins in classrooms
- Put re-use boxes in classrooms where students can access scrap paper
- Use email for assignments and instructions
- Make a worm farm for recycling refuse



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- Have students take notes instead of handouts
- Give students individual whiteboards to take notes on
- Photocopy on both sides of paper where possible
- Hand back handouts when finished
- Plant enough trees per year to cover the annual amount of paper used by the school.

Once the final reports were prepared, the principal accepted these and wrote an email to each member of the class in recognition of their research.

In summary, this Task provided many opportunities for extension and development for various levels of multiplicative thinking. It could have been much richer if we had been able to allocate more time to the investigation and the strategies involved, and also to the protocols of preparing a report – however we were generally happy that the students were engaged, interested in the task and valued their work.

Class 2

As the first class to commence the Task, Class 2 stuck to our original plan of spending one period per week for 4 weeks on the investigation. This was later reported as a problem because the students needed continuity.

We organised the students into groups according to their LAF Level.

As a first step in their investigation, the students decided to count the amount of paper available for photocopying. We then asked ‘Is there another way to find out how much paper is used?’ Students decided to ask the office – and did so. This created a rush to the office and later generated data provided (see worksheet 2) to reduce stress on the office staff when other classes did the same thing.

We then asked, ‘How can we work out how much paper we use per term, semester, year, and what this costs?’ and students used calculations to do this.

The next question was to find out how paper is used, and the students decided to conduct a survey.



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The third part of the investigation was to make three suggestions for saving paper and to explore the associated assumptions. For example, many students suggested that both sides of the sheet should be used and this would save 50%. We expanded upon some of these suggestions, asking 'Is it practical to photocopy on both sides for every purpose – and what is a reasonable prediction of how much can be double sided and therefore how much would be saved? What percentage is more reasonable and how can we test this assumption?'

Overall, there were some problems with the approach taken with this class. We found that there was not enough time to capitalise on the teaching opportunities provided by the task and that it needed to be supported by mini-lessons. Grouping the students according to Level meant that we spent a great deal of time with the lower group and assumed that students at other levels were able to work independently. This may have resulted in minimising the task rather than extending it – however, this is also a result of lack of time and the need to produce a final report. Mixed ability groups, we decided, would alleviate this problem to an extent, as well as overcoming the problem we found of there being so much help given in some cases, that it was difficult to recognise how much was students' work and how much was teacher advice.

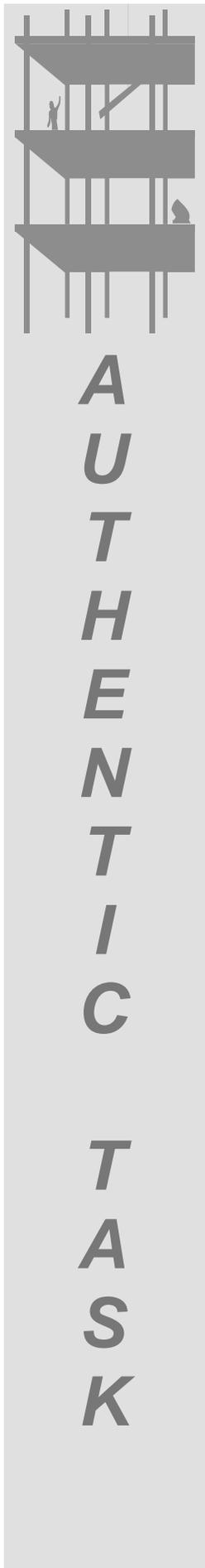
With this class, it was decided not to use the assessment rubric because the criteria were too broad and not specific enough for this task.

Class 3

Students decided that they could use the paper counter on the photocopier as well as counting the paper stocks and keeping a weekly table of paper use. The number of "clicks" on the photocopier did not equal the amount of paper used each week and this had to be rationalised by the students – this was not easy at first – students tended to be very literal in their expectations of the 1:1 relationship between the numbers on the photocopier and the paper supplies.

Students made a lot of assumptions and these were challenged in class discussions, and the concept of averaging data in order to make predictions was explored.

We found that the students were able to do the calculations and to find the information, but were more challenged by question posing. They were required to ask three questions which their data and information could answer, and to show how their data would provide the answers to these questions. This proved to be very difficult for the class and we were surprised that the students had trouble framing questions that could be researched further. Much of the class time (5+ periods) was spent discussing concepts of reliability and extrapolation of data, and the students needed guidance to generate questions and determine



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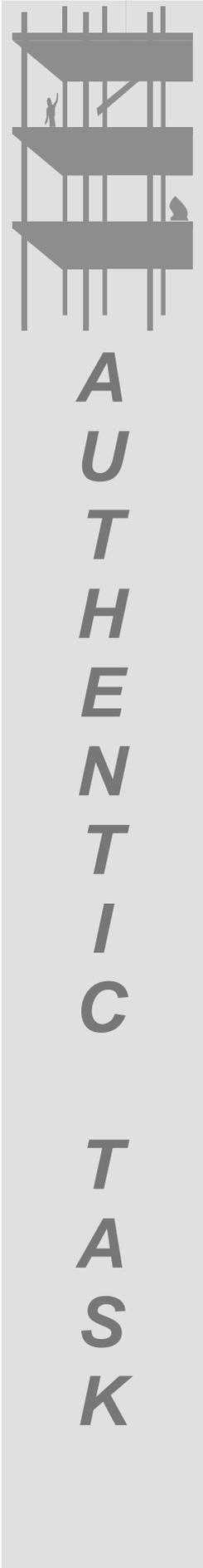
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how the data could be used to find answers, as they were inclined to jump straight to answers rather than demonstrating the steps in mathematical thinking and showing calculations in a final report.

In addition, time had to be spent interrogating the data as the students tended to be too accepting of 'facts' rather than questioning their results or seeing inconsistencies in the data they collected, for example, the photocopy numbers did not match the paper stock tallies.

The investigation was not used as a graded assessment task in this class, and as a result, not all students produced a final report.



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Worksheet 1:

Your task: Prepare a report for the principal which shows how we use photo copy paper.

As a minimum, you must include data about the following:

- *How much paper is used in a week (by you, your class and the school)*
- *How you and your class use the paper you are given in a week.*
- *What happens to the paper you receive? (What do you do with it?).*

In addition your report must use as much mathematics as you can (showing your mathematical thinking and working out) to present your data and your interpretation of this data.

For example, you could use tables, tallies, graphs, fractions, percentages, diagrams, scale drawings, etc to show the data and to make predictions and recommendations about how we use paper in this school.

You may collect other data to use as well and you may extend the task to discover other interesting facts.

The report should also use the data as evidence of why we should be aware of how much paper we use. You may use this evidence to suggest improvements.

Hint: A possible structure for your report could be:

Introduction: Why did we do this investigation – why is it important?

Method: What did I/we do?

Results: What did I/we find out?

Discussion: What do our results tell us?

Conclusions: So what? What could we do about this in the future?

What have we done so far?

- We have discussed the assignment and planned together what we could do. (5 whys, structured brainstorm listing questions and tasks as ideas)
- For one week you have collected, as individuals, a daily tally of how many pieces of paper you have received. You can do a lot with this data.
- We have begun to consolidate this data onto a class tally. (Finish this on Monday if possible) We will give each person a copy of the class data as soon as possible.
- We have investigated how much paper is currently in the photocopy. It doesn't matter if people have different amounts – it is how you use the data that matters. ***Please write down the strategy you used to work out how much paper is in the copy room.***

What we still need to do:

- Revisit the photocopy room on Friday to see how much paper is left.

What we could do:

- Collect any other data you think will be useful and practical.

Timelines:

A draft of your report is due Friday 10th June (2 weeks)

We will spend week 8 working on this in class – you will need to work at home as well.

Worksheet 2 – Important Data

Other useful information:

We get one pallet of paper delivered per term.

There are 40 boxes per pallet

5 reams per box

500 sheets per ream

\$4.75 per ream

RUBRIC FOR PAPER INVESTIGATION

Criteria	4	3	2	1	0
Explanation of steps in solution and reasoning	A complete response with a clear and detailed explanation.	Solid response with clear explanation of most steps.	Some explanation but unclear or lacking detail.	Little explanation. Misses key points.	No explanation
Use Of Visuals	Clear diagram/s, graphs or sketch/es with some detail.	Clear diagram/s, graphs or sketch/es.	Diagrams, graphs or sketches miss some key points.	Inappropriate or unclear diagram/s, graphs or sketches.	No diagram/s, graphs or sketch./es
Accuracy of Mathematics and reasoning	No maths errors, reasoning is logical.	No major maths errors or serious flaws in reasoning.	May be some serious maths errors or flaws in reasoning.	Major maths errors or serious flaws in reasoning.	No evidence of Mathematical accuracy or reasoning
Demonstrated Knowledge	Shows complete understanding of the questions, mathematical ideas, and processes.	Shows substantial understanding of the problem, ideas, and processes.	Response shows some understanding of the problem.	Response shows minimal understanding of the problem.	Response shows a complete lack of understanding for the problem
Requirements	Goes beyond the requirements of the problems.	Meets the requirements of the problems.	Meets the requirements of most of the problems.	Hardly meets the requirements of the problems	Does not meet the requirements of the problems.
Presentation and organisation	Neat, orderly, easily read and set out to be easily followed	Mostly neat, orderly, easy to read and set out to be easily followed	Some attempt to be neat, orderly, easily read and set out to be easily followed	Lacks at least 2 elements of neatness, order, ease of reading and/or setting out to be easily followed	Is not neat, orderly, easily read or set out to be easily followed
Personal skills	Met all deadlines and showed high level of personal planning and organisation	Met all deadlines with assistance in personal planning and organisation	Met some deadlines and showed some personal planning and organisation	Met no deadlines and showed little personal planning and organisation but did submit project.	Evidence of work in progress but final project not submitted.