

such a report for the parents coming to Open Day. This would be a good reason to concentrate on clarity in explanations and descriptions.

Providing the students with a model report:

- ★ *increases their awareness of what a report on a mathematical activity looks like;*
- ★ *increases their awareness of the structure of ideas in a report;*
- ★ *allows students to focus on the contents rather than the form of a report.*

Encouraging students to create their own model report results in students:

- ★ *who are aware of the decisions taken in producing a report;*
- ★ *who know what and how much description, explanation and reasoning to include in a report;*
- ★ *who have an image of what a report should look like and can therefore concentrate on the contents.*

Getting the students to use sentence starters:

- ★ *increased the overall amount of writing and the quality of that writing;*
- ★ *showed the students that explanation, descriptions and reasoning were a necessary part of a report;*
- ★ *increased the number of explanations, descriptions and reasons included in the scripts;*
- ★ *gave the students the language in which to express their explanations, descriptions and reasoning;*
- ★ *allowed the students to produce pertinent concise reports.*

Further reading

Lee, C.S. and Lawson, C., "Numeracy through Literacy" in *Educational Action Research*, Volume 4 (1), 1996.

Morgan, C., *An Analysis of the Discourse of Written Reports of Investigative Work in GCSE Mathematics*. PhD dissertation, Institute of Education, University of London, 1995.

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Teaching strategies to improve writing in mathematics

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AIM

To improve students' report writing skills in mathematics and encourage them to include explanation and reasoning in their reports.

SUMMARY OF FINDINGS FOR THIS CASE STUDY

- ★ Writing is important in mathematics in the production of coursework and as a tool to improve students' learning. This is part of the communication strand of the National Curriculum.
- ★ Students need to learn about what is expected when writing mathematics. This aspect is often difficult for mathematics teachers.
- ★ Students often find writing about their reasoning and giving explanations for their actions difficult and therefore often do not include these in their written work. This results in lower National Curriculum or GCSE assessment than might otherwise be the case.
- ★ Providing a model for students to follow is an important step towards improving the way students write about mathematics.
- ★ Engaging the students in producing a whole-class report on a problem is a good way of producing a model report that is relevant to them.
- ★ Providing "sentence starters" directs the students' attention to the kind of sentence that is required in a report on a mathematical investigation and encourages them to include explanations and reasoning.

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The first strategy – providing a model write-up of an investigation

The students worked on the problem for two lessons to become familiar with it. When they were ready to write a report, the students were divided into groups and asked to concentrate on only one part of the report. Two groups worked on the introduction and description of the problem, two on the method used to investigate the problem and two on the results obtained. Each group was asked to produce, on a large sheet of sugar paper, a rough initial draft of what they thought their part of the report should look like.

“The class had been involved in the decisions taken in producing the report and therefore the style of the report could be adapted flexibly.”

The groups worked for about half an hour on their part of the report and then we stuck their drafts on the wall and discussed them as a class. We looked at which parts were well expressed and what might have been added had there been more time. We talked about what order things should come in and where different ideas fitted in.

After the discussions, we had large sheets of sugar paper with scribbled writing and arrows pointing here and there on them. I took them away and typed up the report that we had decided on, using the students’ own words and ways of expression. This was given to the students to keep as an example or model of how to write up a report on a mathematical problem.

The next time the students were asked to produce a report, they did so happily using the same structure as the one we had produced as a class, modifying it to suit the new problem. The class had been involved in the decisions taken in producing the report and therefore the style of the report could be adapted flexibly. It was not treated as a model to be reproduced slavishly as one produced entirely by the teacher may have been. This seems to be a successful method of introducing students to the way reports on mathematical investigations can look.

The second strategy – using “sentence starters”

Sentence starters were used as a way to encourage students to write about the problems they tackled in a more concise and complete way.

The research started by looking at some scripts produced by a group of students. These scripts were very brief, they contained little in the way of explanation and no reasons were given for decisions that were taken. These “before” scripts contained tables of results, diagrams and some associated algebra. The students only wrote to explain the original problem set and to make an evaluation of the problem at the end. Neither of these contained anything that might be called mathematical reasoning. These scripts left me with some questions:

- ★ *Why was there no explanation of why the students had chosen to look at one shape and not another or how they had formulated their algebraic rules?*
- ★ *Did the students know they should write these things down?*
- ★ *Did the students not know how to write sentences that expressed these reasons and explanations?*
- ★ *Did the students not give conclusions because they found it to hard to give the reasons and explanations that they knew were necessary in a conclusion?*

To try and make a difference to how the students wrote a report on their mathematical investigations, I used sentence starters.

I thought that these would encourage the students to write about what they were doing and to give their reasons for the decisions they took. The sentence starters pointed out that they should write about what they noticed, wondered about, decided etc, thereby encouraging them to do so.

“Sentence starters were used as a way to encourage students to write about the problems they tackled in a more concise and complete way.”

Sentence starters

- I decided to... so that/because...
- I noticed that...
- I noticed a connection between...
- When I looked at the results/table/graph, I noticed that...
- Using the numbers in my table, I looked at... the sum/product/square
- I tried multiplying/adding/doubling...
- This reminded me of the triangle numbers/Pythagoras Theorem/... so...
- I tested...
- I wondered why...
- This didn't work, so...
- This worked, so...
- I already know that... so...
- This is true because...

The “after” scripts were much more expansively written. Many of the scripts contained explanations, reasons and descriptions of what the student had done and why. Only a few of the sentence starters were used a lot but they were used to good effect. Some of the sentence starters that were only used in a few scripts show potential to stimulate reasoning at a higher level of competence.

Frequency of use of sentence starters

I decided to... so that/because...	32
I noticed that...	42
I noticed a connection between...	16
When I looked...	3
Using the numbers in my table...	2
I tried...	30
This reminded me of...	1
I tested...	34
I wondered why...	22
This didn't work, so...	3
This worked, so...	0
I already know that... so...	3
This is true because...	3

Base: 27 scripts

How students used sentence starters

“I noticed that there was a connection between the numbers directly above each other, this is that the number above is four times the amount of the number below.”

“I wondered why the pattern appeared so I tried to find any reason for how it happened.”

“I noticed a connection between all the end numbers, it always went up 8.”

“I did actually wonder why the connection was always the same using big numbers and small numbers. I thought the connections would be different considering the differences in number sizes.”

“This did not work because if you take away numbers from each other then you come out with smaller numbers so eventually you end up with nothing.”

“This is true because no matter how high or low the numbers are or how long the string of numbers are the rule will always apply.”

“This reminds me of the pattern shown in multiplication tables.”

“I noticed the connection between these two walls so I tried adding more layers to the wall.”

“I tested using algebra to work out my pattern and I found that the second row will always become odd because on the first one you always add an odd to an even and that will always make another odd.”

“I decided to do some different addition walls to see if the pattern continued.”

“I tried to see if there was a similar pattern found in a wall made by multiplying numbers instead of adding them. There wasn't really.”

Conclusions

Overall, I was very happy with the effect that these strategies have had on my students’ report writing skills. I shall certainly continue to use them. I feel that the “class report” would be a useful lesson to repeat annually. I hope that the students’ structuring of the information improves each year so that I can concentrate on other details, such as how much to include or where to place emphasis in later sessions. A realistic audience could be given by producing

“The ‘after’ scripts were much more expansively written.”