As a Head of Department planning each year’s curriculum I always consider previous issues. At a planning meeting, colleagues commented on students not “thinking for themselves”. Further discussion about what they meant by this highlighted such instances as students faced with a challenging problem not willing to “have a go and see”, or not thinking through if their answer made sense. It was felt that in year 7 students arrive keen to learn but then switch off by year 9 - we wanted an engaging curriculum that motivated them and encouraged what Guy Claxton refers to as “resilience and resourcefulness”. From a subject specific point of view we wanted to encourage what we defined as “mathematical thinking”.

INTRODUCTION:

From there, we considered Alan Bishop’s cultures, as a summary of skills we wanted our students to develop: Counting, Locating, Measuring, Designing, Playing, Explaining. We also looked at Alf Cole’s “Becoming a Mathematician”, Anne Watson and John Mason’s “Questions and Prompts for Mathematical Thinking”, Mike Ollerton’s “Problem Solving Approaches”, ATM’s “Big Ideas”, Jo Boaler’s “Complex Instruction”, the CAME project, and the Improving Attainment in Mathematics Project’s “Deep Progress in Mathematics”. From this we extracted two main research questions, and a breakdown of how we felt we could encourage mathematical thinking with our year 7s, as illustrated in the diagram below.

LITERATURE REVIEW:

My start point was on curriculums, and in particular Tyler (1949):

“what purposes are we seeking to attain?”

“what experiences can be provided to attain these purposes?”

“how can the experiences be organised?”

“are the purposes being attained?”

From there, we considered Alan Bishop’s cultures, as a summary of skills we wanted our students to develop: Counting, Locating, Measuring, Designing, Playing, Explaining. We also looked at Alf Cole’s “Becoming a Mathematician”, Anne Watson and John Mason’s “Questions and Prompts for Mathematical Thinking”, Mike Ollerton’s “Problem Solving Approaches”, ATM’s “Big Ideas”, Jo Boaler’s “Complex Instruction”, the CAME project, and the Improving Attainment in Mathematics Project’s “Deep Progress in Mathematics”. From this we extracted two main research questions, and a breakdown of how we felt we could encourage mathematical thinking with our year 7s, as illustrated in the diagram below.

RESEARCH QUESTIONS:

My main research questions were:

1. How can I change student’s perceptions of mathematics to encourage mathematical thinking?
2. How can I work with colleagues to encourage a common approach?
3. As the project developed, due to problems encountered, I added a third research question:
   - How can I change student’s perceptions of mathematics to encourage mathematical thinking?
   - How can I work with colleagues to encourage a common approach?

This became a focus for part of the second half of our time delivering our curriculum, as one of our group of three teachers became disillusioned with some approaches, but ended up adding a great deal of benefit, as their cynicism made me re-evaluate and incorporate another approach.

INITIAL FINDINGS:

1. Contrary to my expectations, one teacher and some higher ability students complained about the lessons. A group of three teachers said they didn’t see the point, and the teacher complained of a lack of focus. After further research, I introduced CAME lessons where the learning objectives are made clear whilst retaining an investigative approach, and they were much happier.
2. Malcolm Swan’s research tools from “Collaborative Learning in Mathematics” helped compare the previous year with these students in group panel interviews... prioritising statements about their learning. Here is an example of some findings:
3. End of term test results showed similar results to the previous year on section A (basic topic questions), but improved results on section B (multi-step questions).
4. When offered a selection of a happy, sad or indifferent face to choose to illustrate their attitude towards mathematics, 76% of year 7’s chose a happy face, compared to 35% of year 8’s.

Further analysis is now needed to consider the implications of these findings with regard to the second research question, and comparing the different tasks that were undertaken to answer the first research question.

DATA COLLECTED:

From the above, I put together a curriculum, and all three teachers of year 7 delivered this curriculum to mixed ability classes for the Autumn term.

Data collected included:

- Lesson observations.
- Pupil interviews (including panel interviews).
- Teacher interviews.
- Notes from department meetings.
- Notes from pupil workbooks.
- Pupil end of term tests and questionnaires.
- Questionnaires and interviews conducted with year 8 students to compare results.

There were frequent discussions between the three teachers (one of whom was the main researcher) and alterations were made as a result of some of these discussions.

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WAYS OF STUDENTS WORKING IN THE CLASSROOM:

- Group work, including reporting findings to other groups.
- Conversations in exercise groups between peers.
- Peer tutoring.
- Group discussions—teacher and peer led.
- "Complex Instruction" (Boaler).
- "Deep Progress in Mathematics" (Improving Attainment in Mathematics Project).

WAYS OF TEACHER COMMUNICATING WITH STUDENTS:

- Open-ended questioning.
- Never give a specific answer, but ask another question.
- Talking about/pointing out mathematical behaviour.
- Encouraging students to listen to each other.
- Write down everything

"Questions and Prompts for Mathematical Thinking" (Watson and Mason).
"Thinking as a Mathematician" (Cole).
"Deep Progress in Mathematics" (Improving Attainment in Mathematics Project).

STRUCTURE OF LESSONS:

- Rich starting points.
- Time to think/learn/reflect.
- Cycles where what has been learnt is considered.
- Later on:
  - A sense of aims and objectives being clear to students despite investigative work - CAME project used to have mini-cycles within lessons to give students a sense of achievement.

Tasks undertaken:

- 1089.
- Multiplication Methods.
- Frogs.
- Vedic maths.
- Pentominoes.
- TOAN.
- Arithmagons.
- Mike Ollerton’s activities book.
- “Big Ideas” (ATM).
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- Activities from researcher’s personal collection.
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