Developing Mathematical Reasoning and Problem-Solving Skills: An investigation into strategies to develop students’ mathematics in a Year 7 mixed ability class

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Introduction
The aim of this action research project is to develop tasks and prompts that enable students to become better mathematicians, with a greater emphasis on mathematical reasoning and problem-solving – as required in the new mathematics curriculum.

Following discussion within our mathematics department we wanted students to ‘have a go’ at more challenging questions without giving up straightaway (as we were finding with our older year groups), and if we were to introduce this into Year 7 then we could enable students to develop skills that they could use throughout their mathematics lessons.

Key Ideas from Literature informing Action Research cycles
Two key sources: Polya suggests the following steps when solving problems – understand the problem, make a plan, carry out the plan and finally look back on your work. Mason, Burton & Stacey also suggest strategies and prompts to inform classroom practice, and looking at different phases of work – entry, attack and review. They suggest that open-ended investigations involve time spent exploring and looking for patterns.

Methodology & Data Collected
• Initial re-write of Year 7 SOW to include more of an investigative approach.
• Analysis of student work – looking for evidence of their approaches to investigation. Further tasks trialled to highlight key features of problem-solving. Comparison of students’ work (as a ‘before’ and ‘after’ approach after each intervention).
• Reflective journal – notes on lessons / tasks and questions that students asked about the tasks. Record of any difficulties students had with tasks. Listing of things learnt from task & evaluation student learning.
• Questionnaires for other teachers asking how they were finding with our older year groups, and if we were to introduce this into Year 7 then we could enable students to develop skills that they could use throughout their mathematics lessons.
• Prompts / Questions to ask from literature:
  - Can you draw a picture?
  - Can you restate the problem in your own words?
  - What are you trying to find?
  - What do you know?
  - Can you find a special case?
  - Can you generalise?
  - Do you know of a similar problem?
• Students creating their own questions to form their own investigation of a task:
  - noticing patterns
  - Accessing the maths at their own level – working within their own difficulty
  - Encouraging a conjecturing atmosphere – a ‘what if approach or a ‘does it always happen?’
• Students' written reasoning skills – students have developed strategies to use in investigations and, although they can discuss their work, find it difficult to write-up their results.

Rationale & Key Research Questions
The new national curriculum has three key aims: for students to become fluent in their mathematics; for students to reason mathematically by ‘conjecturing relationships and generalisations’ and ‘developing an argument; justification or proof using mathematical language’; and for students to solve problems and persevere in seeking solutions.

• What are the key elements of problem solving?
• How can I use different tasks to let students experience various strategies for problem-solving?
• What do students find difficult about problem-solving?

Initial Conclusions
• The investigative methodology developed, including the initial prompts and questions, is an on-going process, especially since the Y7 curriculum is changing.
• Focusing on students’ own inquiry appears to lead to greater motivation – with students spending longer on tasks and beginning to form conjectures.
• Next cycle of intervention: ‘improving students’ written reasoning skills – students have developed strategies to use in investigations and, although they can discuss their work, find it difficult to write-up their results.

References
Polya,G (1957) How to solve it, Princeton University Press