Enquiry-Based Learning

By Mike Ollerton 21 March 2013

INTRODUCTION

A short piece of writing about enquiry-based learning (EBL).
Also have a look at Andrew Blair's fab website:
www.inquirymaths.co.uk

Strategies for implementing and implications of enquiry-based learning

The underpinning pedagogy of enquiry-based learning (EBL) is for learners to gain and to use & apply knowledge in ways which places responsibility for the learning upon students. This is at the heart of supporting independent learning and requires the teacher become a facilitator of students' knowledge construction; as a key aspect of sense-making. Below are some strategies which the teacher can consider utilising both in their preparation and their moment-by-moment interactions with students. I also consider some implications of using these strategies

Planning stage	**Rationale and implications**
Ask students to find out something about a concept or broad topic area prior to the lesson. See: "Supporting independent learning and conceptual development"	This puts greater responsibility on students and means they can arrive at a lesson with some knowledge thus preventing them from having to be 'thinking on their feet'. Two downsides of this approach could be to: a) spoil a surprise, b) undermine students investigating a situation where the teacher wants knowledge to emerge as an outcome.
Ask two pairs of students, to each prepare a PowerPoint in order to present existing knowledge to the class	Presentations are intended to remind students of a concept you expect them to have previously met in order to build on this concept. For example if you want them to explore recurring decimals you might want them to make presentations of facts they know about fractions and decimals. If you intend them to explore Pythagoras' theorem you might ask them to make presentations of what they know about square numbers
Plan an accessible task which students can do and explore further	1) Finding tasks so everyone can make a start means students are included and less dependent upon following a teacher's explanations or having to make sense of their peers' answers to closed questions. 2) Well planned tasks lead to students being able to construct knowledge (e.g. slanted squares leading to Pythagoras' theorem and the rotating arm leading to sine and cosine)
Planning extension tasks	Having an idea of how a task can be developed so we can extend students' thinking by posing deeper questions and by suggesting further tasks is essential. Equally essential is for colleagues to share their planning and their ideas. This may well be time-consuming in the short term. However, the benefits in the long term of sharing of best practice will be of far greater significance.

In lessons	Rationale and implications
At the beginning of a lesson pose an open question and provide students with thinking time, perhaps discussing the question in pairs. For example: "Discuss everything you know about angle"	1) This is another way of giving students thinking time. 2) By indicating that <u>you</u> are going to ask students to respond means you are not going to ask for 'hands-up'. The teacher might choose some of the less confident students to make the initial contributions. 3) By making a précis of each contribution on the IWB they can be saved and returned to later in the lesson or in the unit to see how each contribution formed a part of the concept under consideration.
The teacher explains and describes a process so students are able to find knowledge out for themselves	For example, though paper folding students can work out for themselves: equivalence of fractions, how to add, subtract, multiply and divide fractions all without the teacher explaining how to perform such skills. Thus students learn to work independently in order to make sense of skills and concepts. A second example would be to use the unit circle to make sense of sine and cosine.
During the course of a whole class discussion using wait time between asking one question and before asking another	Research showed (Rowe 1972) the average wait-time between the teacher asking a question and speaking again when no answer was forthcoming was less than 1 second! This might possibly be because the teacher wants an instant answer to a question or they are uncomfortable with silences in question-answer situations.
Holding a discussion about 'stuckness' and ways students might try to become 'unstuck'	This is about developing the culture of one's classroom. It is also aimed at students becoming less teacher-dependent by a) thinking something through by themselves and b) asking another student for help before asking the teacher.
Asking students to be explicit about what they think they have learnt or what they have achieved in the course of a unit.	This is, in part, is about self assessment. Being explicit about the essential knowledge they have gained or specific mathematical vocabulary they have met might be done by keeping a journal.
Asking students to make up practise and consolidation type questions for each other	If students come to expect to construct as well as answer questions, they will not only become less dependent upon textbooks, they will often write more meaningful and sometimes harder questions than those posed by in a textbook.
When not to talk: intervention –v- interference	The traditional roles of a teacher are to talk, explain, model and give speedy answers to students' questions. However an EBL approach to teaching demands teachers becomes less 'hasty' to intervene. At issue is when an intervention might actually be interference. For example by drawing a class together in order to move the class 'on'. For some students, who are not ready to be 'moved on' such a scenario might undermine an achievement or an understanding which was possibly moments away – this is a bit like "*If you don't want to know the football scores look away now*!".
Developing a concept and extension tasks	There are a number of generic questions a teacher can pose to students in order to deepen knowledge and understanding and I develop some examples below…

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Questioning

My inspiration for the following questions emerges from the ATM publication "*Thinkers*" by Chris Bills, Liz Bills, Anne Watson and John Mason

a) Give an example of…two numbers that total to make 10… another and another.

b) Give an example of two numbers with a difference of 3… another and another.

c) Draw example of a rectangle with an area of 20cm^2… another and another.

d) Give an example of the dimensions of a cuboid with a volume of 30cm^3 … another and another.

e) Give an example of a pair of co-ordinates on the line $x = 3$… another and another.

f) Give an example of a pair of co-ordinates on the line $y = x$ another and another.…

g) Find a way of changing 2 to 7… leading to… another and another.

h) Find some lines that pass through the point (2, 7) … another and another.

i) Give an example of a fraction that is less than ½ and larger than 1/3… another and another.

j) On a square 9-dot, give an example of a quadrilateral with an area of 2cm^2… another and another.

k) Give an example of two shapes formed when a rectangle is cut with one straight line… another and another.

l) I begin with 2 and divide it by another number; the answer is >2 and ≤ 4. Give example of a calculation I could have made … another and another.

m) Give an example of three integer values that form an acute-angled isosceles triangle…

n) Give an example of three integer values that form any acute-angled triangle…

o) Give an example of three integer values that form an obtuse-angled isosceles triangle…

p) Give an example of three integer values that form any obtuse-angled triangle…

We can use this "Give an example of …then another, then another" questioning strategy for a plethora of tasks. Many of the above can lead to students forming generalisations and this will challenge all students. The forerunner of "*Thinkers*" was another ATM publication "*Questions and prompts for mathematical thinking*", also by Anne Watson and John Mason.