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Planning mathematics lessons

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Chapter One – Planning Mathematics Lessons

Robert Ward-Penny and Clare Lee

For an emerging mathematics teacher, planning is fundamental. A good lesson plan can provide a foundation for both effective teaching and successful learning. Planning can also help to tackle many of the concerns and fears that student teachers have during teaching placement; in the words of the author Alan Lakein, “planning is bringing the future into the present so that you can do something about it now.”

As people think and organise their thoughts in different ways, planning is a personal process. You must develop techniques and habits that support your own teaching, and this chapter is intended to set this process in motion. It contains a number of practical activities which you can use to develop your planning skills whilst on teaching practice. As you read through this chapter, you might find it useful to have to hand a copy of any *pro forma* documents which your training institution or mentor have provided, and if possible, some examples of lesson plans which you have already written.

Beginning to Plan

There is no one correct way of planning a lesson. Some students find it useful to sketch out some rough ideas before starting to fill in a formal lesson plan. For instance, you might start with a large piece of paper and write down everything that comes to mind about that concept. You can then pick out the most important aspects for a particular class and draw a path around the ideas (figure 1.1); this path forms the basis for a more formal lesson plan.

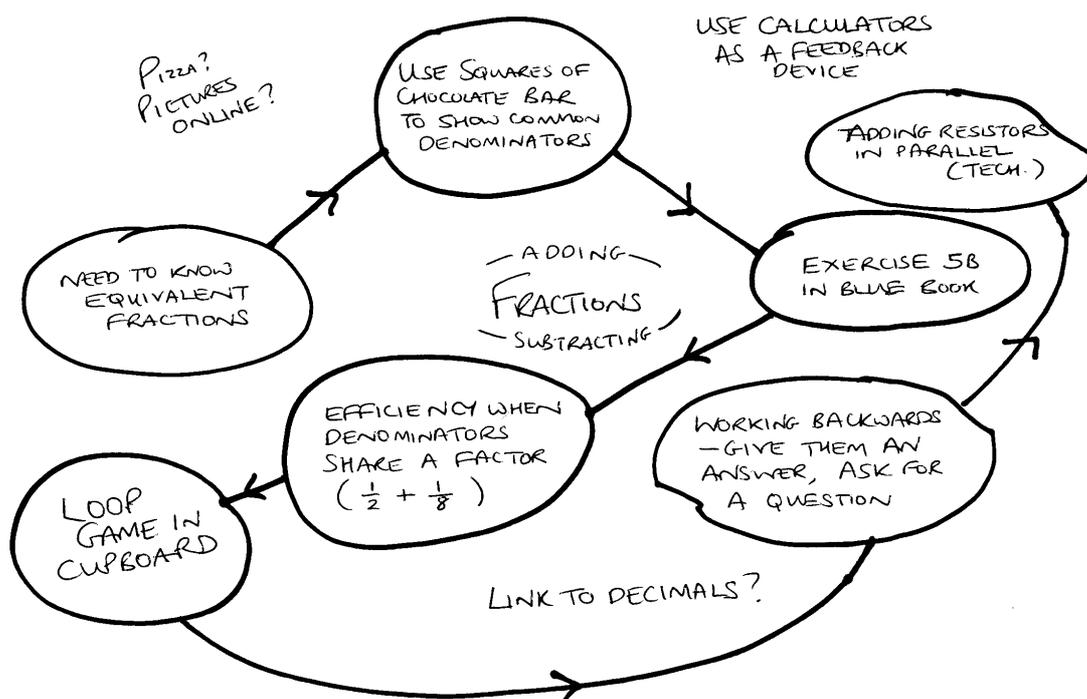


Figure 1.1 Informal Planning Diagram for ‘Adding Fractions’

TASK: Sketch an informal planning diagram for teaching co-ordinates, and draw a path through it in a similar manner to figure 1.1. Do you think you would find this approach useful when starting to plan a lesson?

One of the most common ideas currently used in planning mathematics lessons is the three-part lesson: starter, main and plenary. This is a useful starting point, as it reminds you that pupils’ attention spans are limited, and that moving between tasks can maintain pupils’ focus and bolster their learning. However, it is intended as a structure, not a straight jacket; for instance you might find that a longer lesson requires a mini-plenary in the middle, or two iterations of each phase. Similarly, extended work such as investigations may call for a more holistic approach.

TASK: Observe a range of experienced teachers and focus on the ways in which they structure their lessons. How do they use or adapt the idea of the three-part lesson? How do they alter the structure of their lessons to suit different classes?

Planning Effective Starters

An opening or introductory activity can serve a number of different roles in a lesson:

- **Linking Back** – start a lesson by reflecting together on what your pupils already know. If a class is in the middle of a series of lessons, you might choose to briefly recap the previous lesson. For instance, you might ask pupils to work in groups to create a spider diagram of everything they know now about “area”. This information can then be added to throughout this and subsequent lessons.
- **Looking Forward** – begin with a problem which the pupils cannot yet solve efficiently. For a lesson on the n th terms of sequences, you might start with some simple linear sequences. Can the pupils find the tenth term of each sequence? What about the millionth term? Returning to the same problem at the end of the lesson can help pupils explicitly recognise their own progress and the purpose of the learning.
- **Mental/Oral Starters** – a good opportunity to develop each pupil’s facility with mental mathematics. This might take the form of a generic game such as bingo or ‘Countdown’, or be tailored to support the learning objectives. For instance, if you were teaching a lesson on straight-line angles you might present a 3x3 grid of numbers, where four pairs of numbers add up to 180 – can the pupils find which number is left over? Similarly, a mental starter on multiplying fractions can support a lesson on tree diagrams and pre-empt difficulties.
- **Real World Starters** – a starter involving manipulating numbers drawn from the real world. For example, pupils may work in groups to answer “how many toilet rolls do you think the UK uses each year?” or “how many letters do you think fit in a post-box?” and then defend their responses. Questions can also arise from recent headlines or from the calendar, for instance: “how many gifts were given in total during the song ‘The Twelve Days of Christmas’?”
- **Focusing Starters** – starter activities can also be used to help manage behaviour. Having an activity such as a puzzle ready at the start of a lesson

can direct pupils' attention as they enter the room. For instance, pupils could have five minutes in pairs to see how many playing cards they can make into a stable house, or play a reaction testing game on the interactive whiteboard. In both cases, pupils who arrive and settle promptly benefit from doing so.

TASK: Choose a mathematical topic which you might soon have to teach, for example calculating the mean from a set of discrete data. Which of these types of starter do you think would be most appropriate for this topic? Sketch out two or three ideas for starters which you might like to try for yourself.

NOW TRY THIS: Drawing on the ideas offered above, your own ideas and your observations, write down a list of at least five different starter activities. Whilst on placement, try these out in the classroom and make notes. What worked well? What was less successful, and why? Did any types of activity particularly suit different groups?

Planning for Learning

The *learning objective* is central to planning mathematics lessons. You will usually draw this from a medium- or long-term planning document. However, you should also think about *learning outcomes* in your planning. These will help you to structure and differentiate pupils' learning in more detail. As an example, consider this learning objective: *be able to visualise and use plans and elevations of 3-D objects*. You might choose to deconstruct this objective into three learning outcomes.

Can you:

- identify 3-D shapes when given plans and elevations?
- draw plans and elevations of basic 3-D shapes?
- work with plans and elevations that include hidden (dotted) edges?

This offers a logical structure for progression within the lesson: you might start with a whole-class exercise where the teacher projects plans and elevations of real-world objects onto the board for the pupils to identify; move onto a worksheet with simple 3-D shapes from which the pupils have to draw plans and elevations; conclude with a practical exercise where pupils make a structure with blocks and then sketch the corresponding plan and elevations.

TASK: Starting with the learning objective “*understand Pythagoras' theorem and be able to find missing side lengths in right-angled triangles*”, write down a set of outcomes for your pupils that would indicate a clear progression towards a good understanding of and ability to use Pythagoras' Theorem. How might you develop these outcomes into activities for the main part of a lesson?

Planning for Variety

If you ask your pupils what they want from a 'good' lesson they are likely to mention variety, group work and choice. It can be challenging for a new teacher to plan for variety, since transitions can be difficult stages to manage. One rule of thumb is to change the activity roughly every 15 to 25 minutes, unless what the pupils are doing demands more time. Signal the change before it happens, for example by saying 'in

five minutes I will want you to put those blocks away and get some spotty paper' or using something like a countdown clock on your interactive whiteboard to keep both you and the pupils to time.

Variety in lessons involves a balancing act between several aims. For example, you will need to balance:

- giving your pupils time to build their understanding of mathematical concepts *with* setting aside time for consolidation and practice
- encouraging the pupils to think and reflect individually *and* allowing them to talk through ideas with others
- providing ways for your pupils to see, feel and touch *with* requiring them to read diagrams and develop their ability to visualise

TASK: Think back over several lessons that you have observed or planned and think about the ways that pupils worked in those lessons.

It is likely that many of your lessons so far have included individual work using textbooks or worksheets, partly because that is the way mathematics has been taught in the past, but also because that might feel safe while you learn to keep control in your classes. The chapters in this book are full of practical suggestions which can help you introduce variety into your teaching. However, you can also vary the way in which you use the textbook itself.

Making the Most of Textbooks

Textbooks are a common feature of mathematics classrooms, and they can be a valuable source of practice material. Over time, however, pupils will tire of simply working through lengthy exercises, so it is worth considering different ways in which you might plan to use a textbook.

- **Not Every Question** – which questions do learners need to attempt to work towards the learning outcome? Would it suffice to only do the odd questions, or the prime numbered questions? Perhaps the pupils could decide how confident they are and choose themselves, for instance, selecting five questions from a set of ten.
- **Reverse Engineering** – start by considering with the pupils how the questions are graded. What makes question 2f ($a^2b \times ab^2$) more challenging than question 1d ($a^2b^3 \times a^4b^2$)? Where do they think most people will make mistakes? Which question is the hardest, and why?
- **Do It Yourself** – get the pupils to write a textbook page for themselves. How will they introduce the topic? Will they include examples? What questions will they include, and why?

Many modern textbook series come with teachers' guides and linked multimedia resources. These might also provide you with ideas to support your planning.

TASK: Find a mathematics textbook and choose a page at random. What do you think are the strengths and weaknesses of this page? If you were planning to use this in the classroom, how might you adapt it?

Planning Appropriate Plenaries

Plenaries do not just happen at the end of a lesson! The intention of the plenary is to focus and consolidate pupils' learning, although just as with the starter activity, it is possible to reach this goal in many ways.

- **What can you do now that you couldn't at the start of the lesson?** – you might tie this in to the starter (see 'looking forward' above) or end by looking at a question which pupils can now attempt.
- **Coming Soon** – look ahead to the next lesson or section of the lesson. You might even set this up as a challenge; if you've just looked at linear sequences, offer the pupils a quadratic sequence and challenge them to find and justify the next three terms by the start of next lesson.
- **Why does this matter?** – an excellent opportunity for exploring the relevance of mathematics in the wider world. For instance, you might finish off a lesson on formulae by looking at formulae that pupils have already met in science and technology lessons, or conclude a lesson on probability by looking at the national lottery.
- **Pupil-led plenaries** – occasionally ask pupils to prepare a one-minute presentation about what they think they have learnt. Another version of this is to hide the learning objective at the start of the lesson and ask pupils to guess what it was at the end of the lesson. This type of activity can promote reflection in your pupils as well as giving you feedback on your own teaching.
- **Plenary Games** – finish the lesson with a game where the pupils are required to use the skills they have just developed. For instance, a lesson on co-ordinates could end with a consolidating game of 'battleships'.

NOW TRY THIS: During your school placement, try each of these approaches at least once. What other ideas have you come across for focusing and consolidating pupils' learning at the end of a lesson?

Planning Timings

We have now discussed a range of activities that can make up the starter, main and plenary parts of a lesson. Whatever activities you choose, timing is crucial. Some students find it easier to write actual times, such as 10:15 a.m. on their plans, rather than the timings of activities. This allows them to quickly check their progress during the lesson. Another tip is to plan a 'trapdoor' for each lesson; identify in advance one activity which you can drop without interrupting the flow of the learning. It is also worth having an 'extra' or extension activity planned in case the pupils work much more quickly than you expect, or your use of assessment for learning shows that you need to move the pupils on more than you had anticipated.

Once your activities and timings are in place, it is worth adding in some more details. What resources do you need to prepare in advance? If you have a teaching assistant, how are you going to direct them? If you are going to explain a new mathematical concept, what misconceptions are likely to arise, and how will you address them? If you are going to demonstrate a mathematical procedure or technique, do you have plenty of examples pre-prepared? This list is far from complete and might already

seem daunting but considering these sorts of issues at the planning stage can forestall problems and make the practice of teaching much easier. It is also valuable to consider in advance how you are going to ‘signpost’ the lesson for the pupils.

Signposting

Sometimes pupils can appear to be involved in a sort of magical mystery tour, where one thing just follows another and there are no clues to help them know what they will learn from what they do. Signposting helps the pupils understand why they should concentrate on an activity and what they will learn by doing so. It sets out the direction of the lesson by looking back to what has happened and achieved before; showing the pupils where they are now and looking forward to what will happen next, or pointing towards alternative routes.

For example, after a first activity you might restate the learning intention, ask the pupils to reflect briefly on their learning from the activity and then say what is to be done next. ‘Signpost’ moments allow you to give pupils timings for different parts of the lesson, so that pupils can plan how they use their own time to maximise their learning. Good signposting will encourage pupils to be able to say: ‘we’ve just spent time doing ... in order to ... now I’m ...’

TASK: Consider how you might deliver a lesson on negative numbers, or another topic of your choice. On the diagram on the next page, note down some comments or questions which you might use to ‘signpost’:

- the learning the pupils have done up to now (where they have come from);
- what the next learning activity will be (where they are going);
- what options there might be for future or other learning (where you would go if you went down one of the other roads).

Planning Homework

Homework is a valuable part of the learning process which should not be wasted. It is worth spending some time while on school placement experimenting with different types of homework activities. After a lesson on circle theorems, for instance, you might ask the pupils to write two exam-style questions on a piece of A4 paper with the answers on the back. This could form the basis of the starter for the next lesson, where pupils could swap the sheets and see if they came up with the same answers. Alternatively, you might change the form of presentation involved in the homework. Could the pupils produce an ICT presentation or a poster for homework? You might even experiment with essay-style responses to a mathematics lesson, such as “write half a page on how decimals are used in the real-world.”

NOW TRY THIS: Try setting an ‘unusual’ homework task, making sure that your expectations for the task are clear to the pupils. After the homework is submitted, you might like to discuss with the pupils how they feel about the different types of homework they are set by each subject. How might their comments inform your future practice?

Interrogating Your Plan

At this point of the planning process you will have written down ideas for a range of activities; suggested timings and signposts; and any other notes which are individual to your class. However, before finishing it is worth going over the plan and checking it.

Checking your plan allows you to know that it is as good as it can be. You could consider the **types of activity** involved. At each stage, what are the pupils doing and what is the teacher doing? Are the pupils simply sitting and listening for a long time, do you need to plan other activities to promote variety? Another way of interrogating a plan is to consider the **types of thinking** involved. Are the pupils simply practicing a single technique throughout the lesson, or is there space for creative or higher-order thought?

Read through your plan as if you were a particular pupil or group of pupils. How would you respond to this lesson if you were:

- an introverted pupil with low self-confidence?
- a high attaining pupil who completes written work quickly?
- a pupil who cannot concentrate for long periods of time?
- a pupil who struggles to draw charts and diagrams neatly?

You will undoubtedly be able to think of more ‘types’ of pupils to add to this list. Make sure that your plan takes account of any relevant special educational needs, and addresses any behavioural concerns; if you were a pupil who got bored and disrupted lessons, at which point of the lesson would you be most likely to cause trouble? Finally, if you have been set any specific targets by your mentor, it is worth interrogating the plan to ensure that you have integrated opportunities to show how you are addressing those targets.

TASK: If possible, look back at a lesson plan that you have previously written. Is there sufficient variety in the types of activity planned? Did you integrate different types of thinking? If you have already taught this lesson, does reading through the plan as a pupil help you understand why different parts of the lesson were more or less successful?

Planning to Evaluate and Improve

It is easy to neglect lesson evaluations whilst on school placement, as they seem less immediately pressing than many other jobs. However, failing to learn from bad lessons may doom you to repeat them, whilst you will also want to fix the good ideas in your mind. Evaluation can also help you manage personal challenges; it is much more productive to identify problem areas to be developed than to simply label the lesson ‘bad’ and move on.

Start your evaluation by focusing on the learners. Did the learners achieve the objectives of the lesson? How do you know? If a large enough number of learners did not meet the objective, you might decide to use a different approach or explanation in a subsequent lesson. If all of the learners achieved the objective of the lesson, you might need to consider the level of challenge and the pace of lessons for this group.

You should also evaluate your own choices. Which parts of the lesson went well? Can you explain why it went well? Can this approach be used elsewhere, or developed further? Equally, which parts of the lesson were not as successful? If you were to teach this lesson again, what would you change? How could you support your answers with evidence?

Finally, make sure that you keep a record of ideas that work well. You might find it useful to start a notebook of successful starter and plenary ideas, drawing on your colleagues' experiences as well as your own. Some teachers keep lessons which they know have worked particularly well for them in the past, so that they build up a library of resources and outline plans which can be adapted year after year. You might benefit from starting to do this whilst on school placement.

This chapter has offered you a number of tools and techniques which you might choose to use in your planning and evaluation. It is now your responsibility to select and develop methods which work for you. Proper planning can prevent poor performance; excellent planning can help a lesson shine.

Summary:

In this chapter we invited you to think about the process of constructing a lesson plan and discussed a number of elements that can be used:

- using diagrams to define the overall lesson structure;
- observing structures used by experienced teachers;
- the use of “effective starters” for each lesson;
- defining the learning outcomes;
- thinking about variety and the use of plenaries;
- thinking about timing and signposting;
- including homework in the plan;
- interrogating, evaluating and improving.