Short video explanations

By **Colin Foster**

People often seem to assume that the ideal mathematics teaching situation is one-to-one tutoring. It is often taken for granted that that's the gold standard, and we'd only do anything else because of resource constraints. We can't afford to give every child their own teacher, in their own classroom, so we have to compromise on the best and be realists.

But I'm not sure this is correct at all. The advantages of one-to-one tutoring are obvious: the tutor has an undiluted focus on that one student, can get to know them better, understand their particular difficulties, gaps and misconceptions, and can be endlessly patient and persevere with one thing until the student is happy with it. But there are also plenty of disadvantages, which I think seem to get less attention.

Problems with one-to-one tutoring

Occasionally, I tutor the children of friends or colleagues with some mathematics. And I often wish there were a larger group present. "What do other people think?" is one of my favourite questions, as is "What do you think about what they just said?", and these don't work too well in a one-to-one situation! I find myself saying, "Imagine someone said … What would you say to that?" but it's artificial. Having a range of live perspectives on some mathematics can be extremely rich. But, particularly if the tutor is being paid, there can be a feeling that the tutor has to 'give their money's worth', and this can lead to excessive talking and 'telling' on the tutor's part, so that they look and feel 'busy'. Giving the student a task to work on, and sitting there watching while they do it, may not look like they are earning their money, even if it might be the best thing at that moment for the student. In the worst cases, the tutor is the only one doing any mathematics, and the student becomes a passive spectator.

Some topics in particular lend themselves well to a crowd. For example, for a function I might want one person to be the input number and another person to be the output number, and to have different people be different variables, where "Usha's number" is given the letter u, and so on. The letter u is an 'unknown' to everyone except for Usha. Or in geometry or statistics I might want different people to represent different points or positions. I might show something visual and ask people to make an observation or a prediction, and having lots of them is much better than just one.

One obvious strength of tutoring is its open-endedness – you can ask me anything. But the disadvantage of that is that I may be relatively unprepared. Of course, tutors prepare, and I bring the 'preparation' that consists of all the years I've taught these things before to different people. An experienced teacher may be able to stand up any time, any place and explain anything. But when we do that, do we do it that well? I've been teaching mathematics for a long time, but I often think a trainee teacher who prepared a good explanation would do better than what I might do on the spur of the moment.

Packaged video explanations

This has led me to think about trying to 'package' short video explanations of various mathematical concepts, which I am sure are not perfect, but are certainly better than what I could produce in the moment. I've spent more time thinking about the options than I could realistically do in a live situation, and sometimes I do a second take, and do it better the second time through.

Part of the reason my spontaneous explanations are sometimes not that good is the need for *visuals*. In a tutoring situation, I might open *GeoGebra* on my laptop, or visit useful websites, but mostly I'll probably be using pencil and paper and waving my arms around. But if I knew what to prepare, I could do much better – I could make an animation, for instance, which

- zooms in on the number line (Fig. 1, **www.twominutemath.org/gallery/addingfractionssamedenom.html**)
- or rotates the axes of a graph (Fig. 2, **www.twominutemath.org/gallery/graphoffunction.html**).

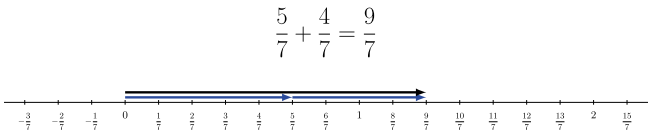


Fig. 1: Adding fractions with a common denominator

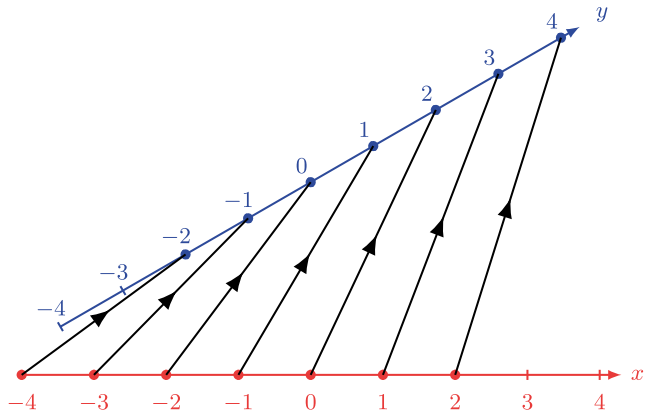


Fig. 2: Creating a Cartesian graph from a double number line

To take one example, on many occasions I have taught solids of revolution to a class by sketching on the board and pointing. I might get out my box of wooden 3D solids, which are great, but unless I had unlikely access to a working lathe or a potter's wheel, I would find it quite hard to convey the idea as well as I would wish to. Contrast that with the kind of thing that is now easy to set up, but takes a few minutes that you simply don't have in an unexpected classroom or tutoring situation (such as shown in Fig. 3, **www.twominutemath.org/gallery/volumeofrev2.html**).

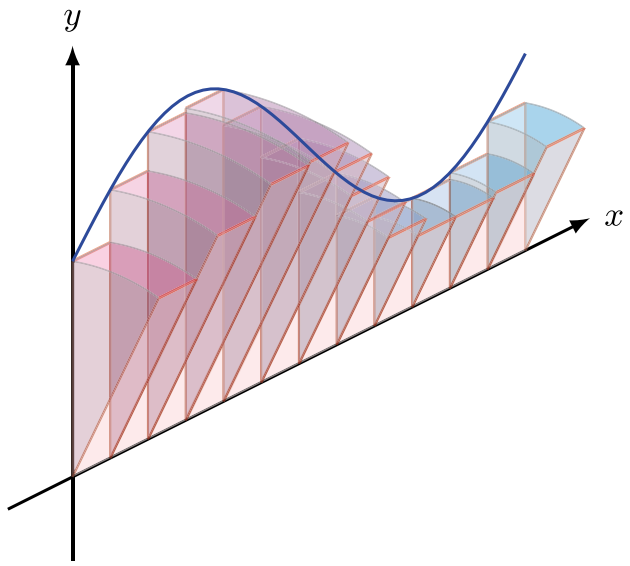


Fig. 3: A solid of revolution

So, motivated by this, I have started to put together a collection of over 160 short 2-3 minute (some a bit longer) videos of me explaining various things, at levels from primary school up to beginning undergraduate. I make no claims of excellence for these, but I could imagine them being used in a few different ways:

1. An experienced teacher might look at one of these short videos and think about what they like and what they don't – what would they do differently themselves? I could imagine the more experienced teacher using the videos *without the sound*, pausing when it suits them, and moulding the visuals around their preferred explanation and discussion points. I think that's how I'd use them myself.
2. A trainee or early-career teacher might watch them to get some ideas to use in crafting their own explanations in their own style.
3. Colleagues might make a professional development opportunity out of watching one of these short videos and then going away and making a different/better one – still with the constraint of aiming for just 2-3 minutes. Then everyone comes back together and watches the different versions and talks about what's different/better/worse between them. I could imagine rich conversations coming out of that that could be more valuable than any of the videos themselves.
4. A non-specialist teacher (or anyone else) might play a video, or part of it, to the class, perhaps pausing at key moments to ask questions or encourage discussion.
5. A student or adult/parent might find the explanations useful to revisit things they themselves feel unsure about. In this case, I've suggested a possible workflow that might be helpful, shown in Fig. 4, based on the idea that *reconstructing* the video and *self-explaining* it afterwards can be valuable for making sense and retaining ideas (Bisra et al., 2018).

I have never been very comfortable with the 'telling' aspect of explaining things, because I worry it can put the learner into a passive, receiving mode, rather than one in which they are actively thinking about and engaging with the mathematics themselves. But I think this depends on how they approach it. I hope that the suggested workflow in Fig. 4 might help students to draw on their mathematical powers to construct their own understanding of the ideas. If a student is pausing, replaying, scribbling on paper, and so on, that may be a marker of deeper engagement than if they are just hitting play and letting it flow over them.

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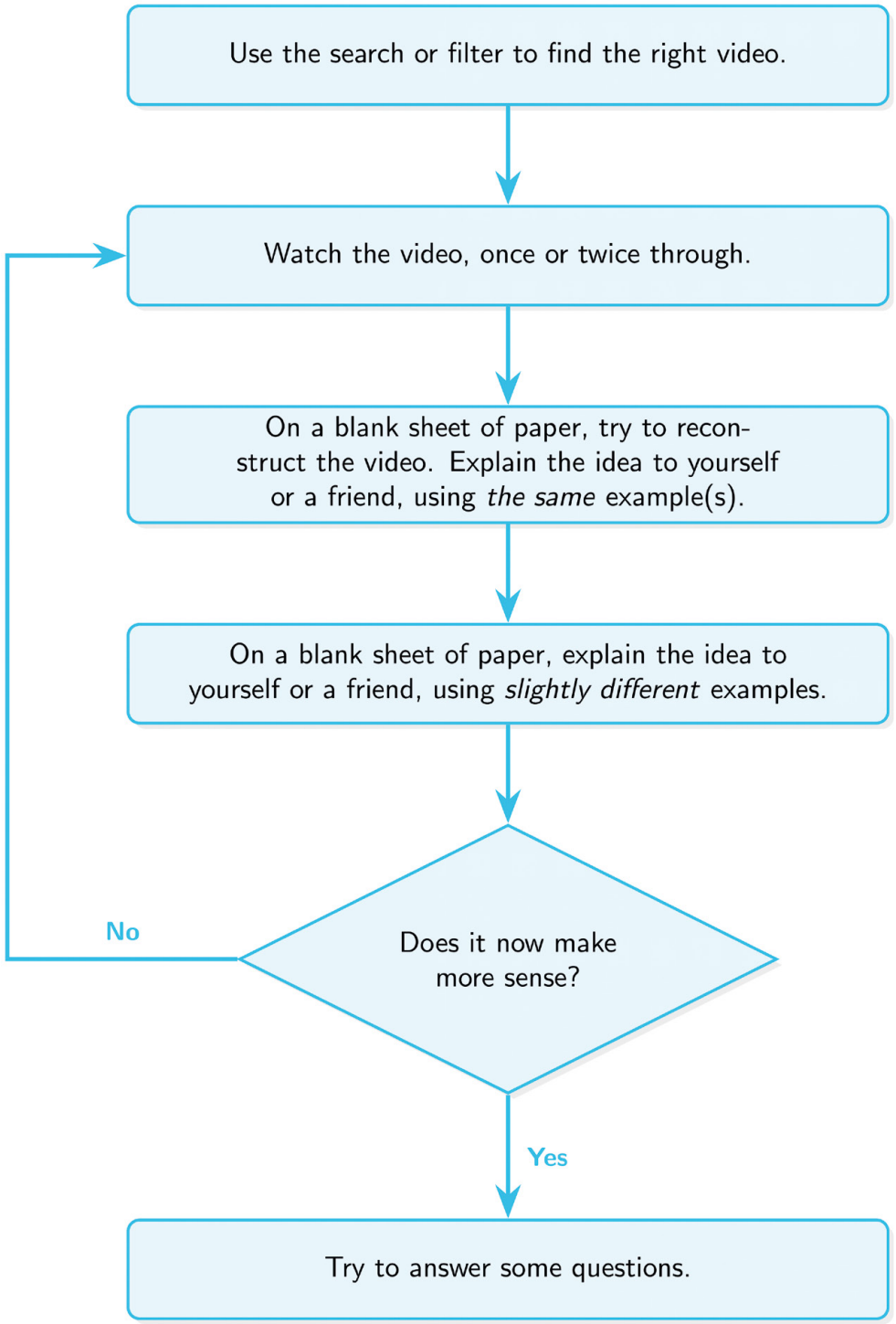


Fig. 4: A possible way for a student to engage with the videos.

References

Bisra, K., Liu, Q., Nesbit, J. C., Salimi, F., & Winne, P. H. (2018). 'Inducing self-explanation: A meta-analysis', *Educational Psychology Review*, 30(3), pp. 703-725.

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