

EMBEDDING DYNAMIC TECHNOLOGIES IN THE KEY STAGE 3 CURRICULUM – THE CORNERSTONE MATHS APPROACH

Liz Gould, Samuel Ikhinmwin, Alex Walley, Alison Clark-Wilson and Celia Hoyles document the development of, and outcomes from, this innovative classroom resource

In this article, we describe some of the outcomes of the ‘Cornerstone Maths’ project. Cornerstone Maths is a USA/UK collaboration that offers teachers of Key Stage 3 mathematics some technology-enhanced units of work that can ‘replace’ several weeks of mathematics teaching. Cornerstone materials are not just ‘any old’ curriculum resources. They have been iteratively designed and evaluated over many years, in the USA and England, in order to embed the use of bespoke digital technology around particular key areas of mathematics, where its potential for enhancing learning is already established due to the use of multiple representations that are visual, dynamic, and inter-connected. Cornerstone also acknowledges the crucial importance of teacher professional learning and offers professional development and involvement with a lively project community.

About the project

Cornerstone will complete and test four units of work by the end of 2014. The focus of these units will be core concepts in Key Stage 3 mathematics: linear function, geometric similarity, beginning algebra, and ratio and proportion (the first two units have already been piloted). These concepts have been chosen because there is already a body of research evidence, national and international, from the last 15 years or so that has showed that, by using mathematical technologies, students can engage with difficult topics and gain deep conceptual understanding. The project research team aims that, by providing what they have found to be an optimal approach, more teachers will be enabled to use technology, as they know that the resources have already been evaluated robustly, and students can succeed in these crucial areas. All the units will be freely accessible on the web.

The first of the Cornerstone units on linear functions is ‘Sand Circle Mobile Games’ in which students are put into the role of a mobile game software designer for which they need to understand the different ways that linear motion can be described.

Figure 2 gives a snapshot of the approach, based on the groundbreaking work of Jim Kaput. It shows a simulation of movement in the top, and the 3 different representations in the other windows.

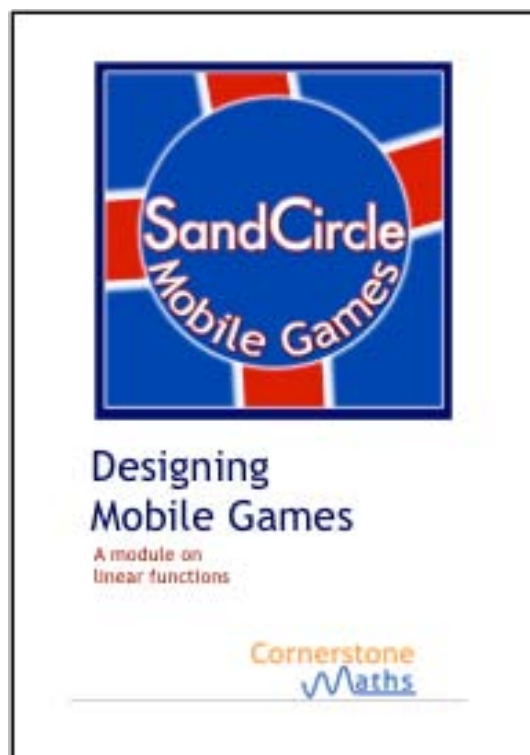


Figure 1 Sand Circle Mobile Games

Pilot Study

A pilot study was conducted in 2011 in which 19 teachers from 9 diverse schools taught the unit to 429 students aged 11-13 years. This research, which was externally evaluated by NFER, adopted the same methodology as its US counterpart project and the English students showed very marked learning gains, similar to those reported in the Texan study.



Figure 2 The multiple representations

The results for student sub-groups, in terms of age, attainment level and socio-economic levels were also analysed showing the learning gains were spread evenly across the sub-groups, indicating that the intervention had positive outcomes for learning and did not widen, or narrow the achievement gap, an outcome consistent with the US studies.

The qualitative data showed positive messages of engagement from students and teachers as well as good alignment with the school mathematics curriculum and that of the National Curriculum. Many teachers of course adapted the unit to fit their schemes of work in terms of pace and lesson style and these adaptations inform the redesign of the project materials and software. Here three Cornerstone teachers describe their experiences. We start with Liz and Alex who were both part of the original pilot and have continued to teach the unit the following year. Then Sam talks about how he happened to be in a pilot school as a PGCE student and subsequently joined the project.

Teachers' Cornerstone stories

Liz: reflections a year after the pilot

My school is a good school with results improving year on year in Peterborough and it was through Ormiston, our academy sponsors that we got involved. I taught the Sand Circle Mobile Games unit last year to a top set Year 7 group. This year I have now taught a similar topic on graphs to my Year 8 class, which contains half of the students who did Cornerstone with me last year, and half who didn't. And, whilst we did build on the mathematics of the topic in the Year 8 schemes, there was a very distinct demarcation in my Year 8 class between those who had learnt it through Cornerstone Maths last year, and those who hadn't. I can categorically say that the retention a year on is significantly better than a class who had done similar work from a textbook.

In fact the Cornerstone Maths unit actually goes much deeper, and it covers things that students may not necessarily have met in Year 7 and they don't necessarily realize that they are learning some of the deeper aspects that they might not otherwise meet until later on. I think that some aspects of the mathematics are quite surreptitious - learners don't actually realize the mathematics behind the activity as they consider it to be part of the software. The other thing I would like to stress is the multiple representation part of the activity. Just last lesson, this time with a Year 9 class, I had a group of four students discussing what they thought was the easiest way to determine speed on a particular graph.

Between them, they all came out with different ways that they thought were the 'easiest' to see the speed; one from the equation, one from the trial, one from the traditional approach, divide distance by time. I think that the fact that they could discuss this concept was also a key outcome from the unit.

With much of the technology-based things that are produced in mathematics, normally the student can just get on with it, just like working on their own from a textbook. This does not promote discussion. This Cornerstone Project does promote and stimulate discussion. And I don't need to encourage student discussions - it naturally emerges as the students are working. I feel that I do not have to stand and directly teach students as much. My role is to facilitate what students are doing and helping them to learn, rather than telling them what to do. Students take ownership of their learning and I have found that they have enjoyed the experience.

Alex: Cornerstone a year later

I became involved with Cornerstone Maths whilst I was doing my GTP training last year in a school that might be described as 'quite deprived' in Stoke-on-Trent. The school had the opportunity to be a part of the project, and myself and one of my colleagues became involved.

It was a really valuable experience for me as a trainee to meet up with other professionals and other institutes, and to get over the initial comparisons of what our pass rates were for GCSE and what theirs were - to actually talk to practitioners about mathematics and their experiences of teaching it was valuable. We had a number of CPD sessions where we were able to sit down together and talk about what had already been developed and how we saw that playing out in our schools. It was about seeing how this big mathematical idea, and this new technology, would actually work in our day-to-day practice.

The benefit for me was being able to say to the students 'there's a big idea, a big mathematical idea that we're heading towards'. And the way that the unit was designed meant that it was a very gradual experience, but the whole time I was aware of things that I needed to make very clear to students, and also the things that I needed to explore more deeply with them. Previously in my mathematics teaching and during my training it would have been very episodic teaching, one little segment, then another little segment. Whereas this unit really seemed to pull everything together for all those involved. The reaction from learners was massively positive. Students were seeing how

the different mathematics worked and how the different mathematical ideas would play out. So, being able to be involved in the development of the project has really paid off for me in terms of developing as a new teacher.

Secondly, I am just starting my third cycle of teaching this unit to different classes and it means that instead of me standing in front of the class and saying *'this is how it is, here's an example, and you're going to do one very similar in a second'*, the learning just goes at the students' own speed and they are able to learn independently. It means that, instead of me standing at the front and looking at who's not engaged, who's struggling, who's starting to talk because they don't really like what they're doing, I am crouching down next to students and having really high quality conversations with them about exactly what they are doing. I am no longer the focal point of the room, the focal point now is what the students are doing, and I am there to bring out the important themes, or the big ideas, or to help students to make the connections. That is the really important bit, the connections between the algebra, and the graph that they're looking at, and the table of values. So, I really feel lucky to be a part of what we've done so far, and I think it has massively helped my development as a teacher.

Samuel: A more recent Cornerstone recruit

I became involved with Cornerstone Maths because, whilst I was doing my PGCE last year my placement school was a pilot school that had been involved in the project from the outset. I was asked by the head of the department if I would be interested in getting involved with a unit of work that was quite different and that would involve a great deal of collaboration and reflection. I started teaching the whole unit on linear functions to a Year 9 top set at Langdon Park School, in Tower Hamlets. After teaching the unit I was asked to reflect upon the outcomes both in terms of my PGCE course, and also in terms of my collaborations with the mathematics team in the school. I was then appointed to Langdon Park School and I have taught the unit again this year.

So I have now taught the unit twice, in full both times, and I think that there is so much rich learning to come out of the mathematical content.

The unit is content rich and I think that, as a teacher, you learn quickly that it is based on core mathematical ideas. It is not based on 'airy-fairy' ideas of 'let's pretend we're learning', it's really about 'let's learn and let's learn as much

as we can', and it targets the different areas of mathematics.

As an example, I have a student, Shelly who is in a mixed ability class, from the second cohort of students that I taught, who is working at around NC level 4, so she is low ability in terms of the group. At the higher end of the spectrum the group includes students who are able to achieve NC level 7. Shelly didn't want to engage with anything we did as a class. But when we started the Cornerstone unit, we put a laptop in front of her and another student who was two sub-levels above her, and she was 'off'. The outcome is that Shelly has achieved much in her learning.

At key times when we stopped and we said *'take five minutes and just write down all the things you've learnt'* Shelly been able to reflect on things, which I do not think she would have learned with any other approach.

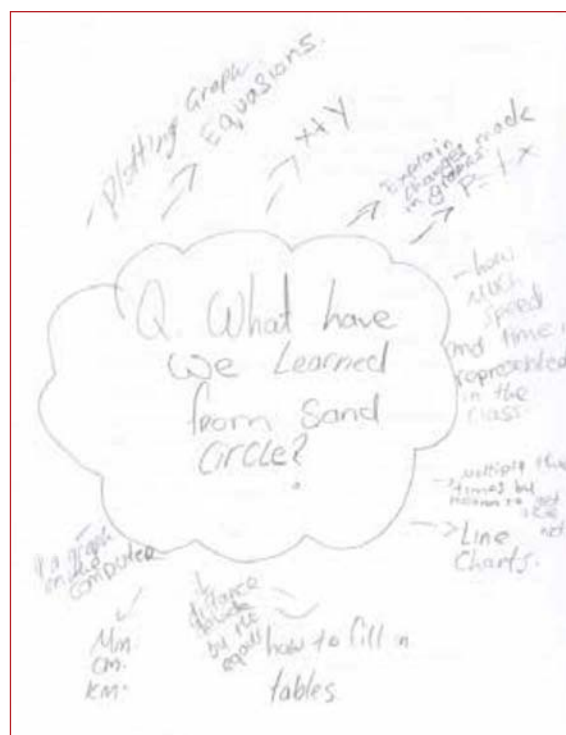


Figure 3 Shelley's reflections on her learning

So I am really positive about the mathematical progression within *Cornerstone Maths* - through topics like linear functions, as I have been able to appreciate how content rich it is.

In terms of the underlying pedagogy, the style in which *Cornerstone* teases out key ideas such as variables, which is a small thing to some learners, but to people like Shelly who are not able to access a more challenging content those ideas are really important. The unit talks about

concepts, and it talks about ideas, from a very content-heavy basis, which allows students to grasp the ideas before the formal mathematical vocabulary is introduced.

So, Shelly already has a great understanding of the use of a variable, before she knows what it is called. Shelly now knows what a variable is, and can now go on to utilise that variable building upon her knowledge. In my opinion it is a very good unit that builds upon many good key ideas and manages to bring them together well.

Conclusions

The *Cornerstone* team is now embarking on detailed evaluations of Unit 2, geometric similarity, as well as putting the final touches to the materials for the unit on beginning algebra. We are continually looking to improve the student and teacher materials as well as the structure of the professional development that is offered. Ultimately we aim to support online communities in different parts of the country - where the community can respond to its own questions. If you or your school is interested in getting involved in the *Cornerstone Maths Project*, please contact us through the project website. www.csmaths.co.uk



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