

The use of ICT (spreadsheets) in mathematics in KS2 and KS3
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A project funded by the NCETM

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**A report in four parts: what we set out to do;
what we did;
what we learnt;
and what we would like to do next.**

What we set out to do

Our project was supported by the NCETM *development and research pathfinders* fund which stipulated that:

This work should be conducted in a Collaborative Practice environment, where the teachers involved plan, observe and reflect on lessons together. The groups should consist of one institution with research expertise and five or six schools or colleges ... Each research project should identify a theme within the general focus of enabling teachers to make effective use of ICT. ... work with a cross-phase element is encouraged.

Before we set out the aim of the project we'd like to describe how we arrived at this aim. After reading the NCETM brief for the project seven of us met (two primary teachers, two secondary teachers and three university teachers). It was a meeting where everyone knew someone but no one knew everyone. We were very excited about doing something in both primary and secondary schools and ICT seemed a really good focus for collaborative work. Half way through the meeting we were arguing about: the focus 'ICT' or 'maths' or 'maths with ICT' or 'ICT with maths'; what software and/or hardware we'd focus on; we'd also raised KS2 to KS3 transition but we not sure about whether we wanted to tackle such a big area. Peter then said "I want this to help my pupils' maths in the time that they are in my school". We all quickly rallied to this: maths was the focus and transition was not an issue – each teacher should look out for the education of their pupils. As for software/hardware, we settled on spreadsheets because they are already in school, have 'obvious' maths applications and seem to be viewed as important by QCA etc. This led directly to our project aim:

To investigate teachers' use of ICT (spreadsheets) to enhance pupils' mathematics subject knowledge in KS2 and KS3

This aim had several dimensions:

- a. To encourage cross-school and cross-phase teacher collaboration with regard to the use of ICT in mathematics in KS2 and KS3.
- b. To investigate teachers' foci in the use of ICT in mathematics in KS2 and KS3.
- c. To investigate curricula opportunities and constraints with regard to the use of ICT in mathematics in KS2 and KS3.
- d. To investigate issues concerning ICT-mathematics task design in KS2 and KS3.
- e. To investigate student engagement with mathematics in ICT-mathematics tasks in KS2 and KS3 and aspects of their understanding of mathematics.
- f. To facilitate within-school continued professional development through focused reflections on task design and lesson observations.

NB by the end of the project (December 2007) we agreed that we had addressed every aim – and done so quite successfully, but more on this below.

We decided to work in two sets of three schools (which we called 'triads') for ease of getting to other schools.

Harrogate triad

Peter Hallam, Tony Staneff, Richard Street

Leeds triad

Karen Avery, Gregory Perry, Rich Wayman

We planned a set of meetings and observations. These are set out in Table 1 below. The reality diverged a bit from the plan but we address this in the next section.

Table 1 Planned schedule of activity

	Activity	Who	Meetings
Jan	Project preparation	Project team	Project team; triads separately
Feb	Initial observation	Schools triads	As needed
Mar/Apr	Task design 1	Schools triads	School triads with university member
May-July	Observations	Schools triads university member	Project team
Sept	Task design 2	Schools triads	School triads with university member
Oct/Nov	Second observation	Schools triads university member	Project team
Dec	Report writing	All	

What we did

Although we kept to the spirit of the planned schedule of activity, the actual work carried out diverged from that planned. We now set out how we diverged from the plan – and our perceptions of why this happened – not as an apology but because we feel there is much to learn from this. We begin with a schedule of actual activity – Table 2 below. NB Table 2 sets out all formal activities. There was actually more activity than is recorded in Table 2 when all informal contact between team members is taken into account – this was substantial but would be a bit boring to record.

Table 2 Actual schedule of activity

	Activity	Who
Jan	Project preparation	Project team
March	Project preparation	Project team
May	Planning meeting	Brigshaw, university
June	Planning meeting	Harrogate
June	Observation of Year 5 lesson	Brigshaw triad, university, NCETM
July	Pilot of planned Harrogate work	Harrogate, three lessons with Year 8
Sept	Planning meeting	Brigshaw, university
Oct	Planning meeting	Harrogate, university
Oct	Observation of Year 6 lesson	Brigshaw triad, university
Oct	Observation of Year 9 lesson	Brigshaw triad, university
Oct	Observation of Year 6 lesson	Brigshaw triad, university
Nov	Observation of Year 7 lesson	Harrogate triad, university
Nov	Planning meeting	Harrogate, university
Nov	Observation of Years 5 & 6 lesson	Harrogate triad, university
Dec	End of project discussion	Brigshaw triad; Harrogate triad
Dec	Report writing	University team

NB

1. We have audio recordings and transcriptions of all meetings, video recordings of lessons and 'screen capture' recordings of three – six pupils ICT work in each lesson (other than Harrogate pilot work). These data (after being made anonymous) are available to NCETM on request.
2. The October Harrogate lesson was a double lesson. The November Harrogate lesson was a triple lesson with classes from the two Harrogate primary schools at the secondary school.

It can be seen, on comparing Tables 1 and 2, that the project had a slow start and a lot of activity towards the end of the project. There were several reasons for this. First, the January project team meeting, which was suppose to reach a point where each triad could go away and plan their work, did not reach consensus on a focus. As Peter said:

I think we're getting somewhere, we're getting to a focus point but I don't think we may be there this evening and I'd like to be a lot clearer in my own mind where we're actually headed ... before we all start going off and doing things.

This was an exciting new venture for everyone and it is not, in retrospect, surprising, although we had a project document, that there were several interpretations of what this document meant – and that resolving these interpretations to get something that could be realised in the classrooms required reflection after the first meeting.

The second reason for the slow start was time – teachers and schools have many commitments and coordinating diaries is problematic. This is an rather obvious observation but it is nevertheless worth noting as mutual planning, observations and post lesson discussions is an expressed way for CPD by NCETM. We share this aim and make a recommendation for a practical way forward to enable greater mutual observation in the last section of this report. The reason for the wealth of activity towards the end of the project was basically down to a feeling *we need to get something done!*

The foci of the lessons

The lessons were, with one exception¹, all broadly around the theme of data handling. This focus arose at the March team meeting (the secondary foci was number patterns but neither triad got on to this). It is interesting to review how this focus came about.

Early in the discussion teachers were talking about ICT graphic facilities.

Peter Very often in a SATS situation the kids are presented with the graph done, the data there and then there's a specific question that's asked about the data, and in my view because they've not been involved in the original analysis of actually pulling the data together, they find that very difficult to interpret. I don't know what it's like at Key Stage 3.

Tony It is very similar in Key Stage 3 ... whenever you go to Key Stage 3 marking meeting, whenever you hear "we've got a trouble question coming up" you know it's going to be interpreting a bar chart or a pie chart ... but if the kids were involved in the construction ... it would be a good avenue to explore.

¹ The exception was the Brigshaw secondary lesson. Is this because secondary teachers, in general, work to a fixed scheme of work, e.g. Pythagoras' theorem in October? If so, then this has implications for joint KS2/3 work.

Rich I think it would be quite good because it would give teachers an alternative to just, give pupils alternative learning than just “I’ve drawn a pretty graph”. It will actually get them to look at what they've drawn.

Later in the meeting we were discussing the potential of data handling work. This clicked with the above comments.

Tony Data handling is something which we'd like to get out of it ... maybe using data provided from their primary school...

Peter One of the most common in Key Stage 2 is tell the story of the graph .. like temperature in a classroom and it's going up and down and you have to explain what is happening to the graph ...

Rich And again going from raw data to graph can be quite a learning experience

So data handling became a focus not so much as a ‘content area’ but because of the perceived reasoning opportunities it offered for pupils working with ICT.

Details of the lessons

There was a basic difference in how the two triads organised this – Brigshaw teachers organised their own sub-foci, Harrogate teachers had a single sub-foci – so we report on their work separately.

Brigshaw

The June Year 5 lesson was a part of a series of lessons on healthy eating. Over Easter the pupils recorded how many distinct fruit and veg they ate each day and the number, for each pupil for each day, was put into a spreadsheet. Pupils performed various sorts and calculations.

In the October Year 6 lesson the pupils, in pairs, were to organise a spectacular 11th birthday party for themselves in a hall to a fixed budget of £300. Variables included the number of people attending, various foodstuffs priced per person and options like a magician.

The October Year 9 lesson was the exception to a data handling focus and presented a problem for a farmer, of where to put linear paths, which required optimisation and the use of Pythagoras’ theorem. Pupils had to be adept at using formulas in Excel, which was problematic.

The November Year 6 lesson involved a direct focus on using spreadsheets. Pupils were given information on other children, e.g. favourite fruit, how they got to school. The information was presented in percentage, decimal and fractional form with some information missing. Students had to use Excel to complete a table represent the information in a pie chart.

Harrogate

The Harrogate triad planned their work together – virtually identical work with all classes – but under the knowledge that there would be some mathematical techniques available to KS3 pupils that would be too advanced for KS2 pupils. The idea was for pupils to analyse data that they had generated. The initial plan, piloted in July, was for pupils to design an ice cream

given a fixed budget with a fixed choice of ingredients. After designing the ice cream, they made it in the D&T food technology lab and evaluated (grades out of 10), to given criteria, everyone's ice cream except their own. They then use a spreadsheet to analyse the grades and pick an overall winner. The pilot worked well with the exception that the ice creams started to melt during the evaluation – in the October planning meeting the teachers decided to use pizzas instead of ice creams.

The pizza activity was first used with a Year 7 class. The teacher was not sure that the pupils' spreadsheets skills were uniformly up to the demands of the analysis and recruited 10 sixth formers to help pupils with spreadsheet work. The triad's post-lesson discussion was not so much orientated to CPD as it was to what to amend in the subsequent KS2 lessons – this is, perhaps, to be expected in iterative refinement of a task but appears as a point worth noting for future NCETM CPD work. The KS2 teachers subsequently configured the spreadsheet so that certain operations were easier for the pupils than they had been in the Year 9 lesson. The KS2 lesson (a whole morning) was held with both classes in a large computer lab in the secondary school. A bonus of this arrangement was both the excitement of the pupils at 'going to the big school' and the opportunity is offered the KS2 teachers to team teach (valid CPD in its own right).

Did we realise the aim(s)?

With regard to a – f on page 1 of this report, the feeling was 'yes', as Tony said:

There's not much we haven't touched on in a to f at all. To investigate teachers use of ICT, to investigate curriculum opportunities and constraints, well we did that in group discussion [planning]. To investigate issues concerning ICT maths task design, we I mean that's what we were doing throughout really. To investigate student engagement with mathematics in ICT.

“we did that in group discussion”, we feel, suggests that the ‘dimensions’ (a – f) permeated the work over the year and points to the importance of the planning discussions. Discussion for planning work that you will actually do with your class is, we feel, often quite different than discussion without classroom activity as an end. We'll expand on this point because what we've said may not be clear so far and we feel it is important. When you are just asked, say, something like “is ICT important in maths?” you can say “yes” because it is sort of the right thing to say. But when you know that you'll be doing classroom work on the things you say you get more precise because you don't want to commit yourself to a disaster. So it's good to have a project that will force you to do something, not just for the sake of doing it but because your thinking develops in discussion (but only in discussions that commit you to do something).

With regard to the single aim, *to investigate teachers' use of ICT (spreadsheets) to enhance pupils' mathematics subject knowledge in KS2 and KS3*, the answer is less straightforward. At one level the answer is YES – just look at what we did, we used ICT (spreadsheets) in mathematics lessons and pupils certainly learnt – though they learnt by applying mathematics rather than learnt new mathematics. However, the question ‘is this maths with ICT or ICT with maths’ was raised by several project members during the observed lessons. Karen, in the discussion following the Brigshaw year 9 lesson, commented that she viewed the difference between this lesson and her Year 6 lesson of the previous week as:

I did ICT with maths in it [but you did a maths lesson with ICT in it]. You see if you'd have done that lesson in an ICT lesson, with their ICT teacher there as well, then I wonder what

difference it would have done then to sort of put them alongside each other. I was talking to the teacher from Switzerland² ... and he said well we don't have ICT lessons, all ICT is embedded in all the lessons, so we don't have ICT lessons. Everything that's done on the computers is within the curriculum in other ways or forms. Which is what we're trying to do isn't it really, embed it in the maths.

We don't think the question 'is it maths or ICT?' has a definitive answer because it depends on what you mean by mathematics. We would argue, however, that creating situations where teachers seriously raise this question points to personal development and thus to legitimate CPD. This important point relates back to the previous paragraph in that 'creating situations where teachers seriously raise this question' is really only likely to happen with real classroom situations.

The NCETM brief "This work should be conducted in a Collaborative Practice environment, where the teachers involved plan, observe and reflect on lessons together."

Collaborative planning, observation and reflection was discussed by Peter, Richard and Tony in the end of project discussion.

Peter It was helpful for me and Richard when you did the first lesson Tony, it brought together the ideas of what we'd been talking about. I mean it was as we had imagined, but I think to actually see it in practice I found very helpful

Richard Most definitely and it was almost a dry run for us and we could see, particularly in the ICT suite when they were going through the tasks, what our children in particular would find difficult. And that was invaluable for me really and that helped us actually go through, create our own worksheets

Peter I think also some of the things that you'd said Richard about how the children had perhaps been phased by all the numbers on the screen and trying to get all that information actually onto one page was quite helpful as well. Tony what do you think from watching us?

Tony I think it's always really useful to watch other teachers teach really. I've done a lot of work with primary schools ... I always think it's useful to pick up those things that you did, like just a little thing like you put your hand in the air ... how you've got to structure things differently because sometimes they might take it a bit more literally than. And so it needs to be a lot more structured really. So in terms of my CPD I think it's always useful.

We also thought that the NCETM was interested in activities that might be recommended to others to try though this was not explicitly stated by the NCETM. Whatever the NCETM view on this is the discussion above moved on to this issue.

Peter I think you could package the thing and say yes this is something that you could offer to other schools. But ... [if you] just sort of pass it down in that format I think it would lose something. I think the elements of competition and, actually making a pizza, I think that just raised the thing a whole quantum leap as far as the children were concerned. ... If you just chucked it out as a package to schools and say have a go at this, I'm not sure many would tackle it.

Richard I agree if you were to give it out to primary schools as a nice neat package it would really get watered down. Because if you think about the support we had, sixth form support for ICT, it's 10, 12 students, we had all the support Year 11s for the cooking ... I can

² An observer in the lesson.

just see [people saying] how much support am I supposed to give, who am I going to get the support from for a package like this. So I think that you're right, that would be an issue really.

Tony The thing about this project was that it was a collaboration between Key Stage 2 and Key Stage 3 teachers. I think it would be really hard to package up. Although there'd be bits of it that you could maybe do something about but it's about those links between differing key stages. And so you've got to have schools prepared. But I think if schools were prepared to do it, maybe not just on this data, but any sort of data, any collaboration, I think the rewards are clear.

Dissemination

We distinguish between informal and formal dissemination without ascribing higher value to either type. Informal dissemination has been going on from the outset with school and university staff talking to others about their work in this project. This has not resulted in other school staff observing lessons (a hope of NCETM). Perhaps this is due to modesty on the part of the teacher-researchers. Perhaps we should have been more pro-active on this front, or maybe NCETM should anticipate modesty (or nerves!) of teacher-researchers and encourage project teams to invite other teachers to observe project lessons.

Formal dissemination has, not unnaturally, only just started. A presentation was made at the November meeting of the *British Society for Research into Learning Mathematics* (BSRLM) based on the first Brigshaw triad Year 6 lesson. A paper on this presentation should appear on the BSRLM website (<http://www.bsrlm.org.uk/>) in February 2008. The team has been invited to present at the March 2008 NCETM ICT conference. To equalise presentation foci between the triads, this will probably be based on the work of the Harrogate triad.

What we learnt

We feel we learnt a great deal, collectively and individually. We summarise our main learning under four themes: about each other; time; about different ways work can be done; about a difference in teachers' knowledge of pupils' ICT skills. We end with an edited extract from an end of project discussion.

About each other

Although none of us entered the project ignorant of the other phase (primary or secondary schooling) we learnt a great deal more about the other phase through discussion, planning work together and by observations.

An important part of this learning could be called 'parity of esteem'. We step into what is often thought but not mentioned – that secondary schools, teachers and pupils know more than their primary counterparts. Aren't we all a little guilty of falling into this trap at times? This project has completely dispelled this myth in the minds of all project team members. This is a good thing to learn. Secondary teachers were very pleasantly surprised by how capable KS2 pupils were in mathematics and in ICT and primary teachers showed a more rounded knowledge of their pupils' combined mathematics and ICT knowledge than their secondary counterparts.

Time

Time takes on many dimensions in learning and teaching: classroom time; planning time; teacher time (and commitments). In this section we address three issues related to time. The first is practical – that meeting for planning or observation takes time when other things are going on in your school. All but one of us in this project are teachers of many years experience – we should have known this but we entered the project thinking we could overcome this obstacle – well, we did but only with difficulty. It is not just non-contact time either because if three or more are going to meet, then non-contact time needs to be at the same time. We put forward a partial solution to this problem in the last section.

The second time issue is time to develop a shared purpose. At the top of page 3 of this report we related the problem at the end of the first team meeting “we're getting to a focus point but I don't think we may be there this evening” – we needed another meeting to establish a shared approach. Perhaps the reason we succeeded in the second meeting was the ‘time for reflection’ between the two meetings. But after we established a team approach, the two triads met separately and again time was needed to establish a shared approach. This leads on to the third time issue – time to build relationships.

After the first post-observation discussion, one of us commented “that was too polite”. Now the lesson was a good lesson – but is any lesson without flaws? The post-observation discussion basically went along the lines of “I liked ...” There is a sense in which you need to know someone well and respect them (and for this respect to be known by that person) before you can really get critical, i.e. you can say “that was rubbish” to a respected colleague but you are unlikely to say this to someone you do not know that well. This is an area open to great diversity – sometimes respect can be established quickly, sometimes it will never come – but, in general, it seems a good idea that post-observation discussions should be many and over a long period so that initial ‘polite feedback’ can be got out of the way and be replaced by critical feedback’.

About different ways work can be done

This observation is made in retrospect and concerns the different ways of working of the two triads – Harrogate conducting virtually identical work with all classes and Brigshaw conducting separate activities. We don't feel that one form is ‘better’ than the other – we feel that both are legitimate and that it really depends on teacher motive, prior perceptions and also curriculum opportunity. These two forms arose without anyone being aware of it until we were towards the end of the project. If there is a lesson for future NCETM projects it is that prior consideration of forms of working together (collaborative or ‘jointly planning separate work’) may be useful to address at the beginning of a project.

A difference in teacher knowledge of pupils' ICT skills

A KS2/3 difference concerned what teachers knew about the ICT/spreadsheets skills of their pupils. KS2 teachers were more aware of their pupils' ICT skills and could tailor their lessons to suit those skills or teach appropriate ICT skills before the observed lesson. Indeed, knowing what your pupils don't know is useful to know for this gives you an ability to design a lesson for pupils to gain this knowledge or to avoid unwanted ways of doing things. An example of the latter was Karen's November Year 6 lesson where she did not want the pupils to know about the % button in Excel, as the main objective of the lesson centred about converting number representations.

In secondary classes, however, there were times when the assumed pupils' ICT skills were not as expected. This, of course, is not the fault of the teacher who has asked the ICT department

about the spreadsheet skills of the pupils – but being told what pupils should be able to do is not the same as knowing this through working with the pupils yourself. Tony was concerned about this and a week before the November Year 9 lesson he wrote:

Worry 1 - Do the pupils have the necessary Excel skills to be able to do what we want them to do? Excel is not taught in Y7 until the last term and I worry that they won't remember using Excel at primary school. Now I have some further maths pupils at hand who could help them out.

So there's something we didn't expect to find – that KS2 teachers are actually in a much better position to use spreadsheets for mathematics than are secondary mathematics teachers.

What we would like to do next

We would like to keep the project going because we feel that this could be the beginning of something ongoing. The NCETM project has come to an end but we will be meeting early in the new year to review the project as a team (which was not possible in the December review). We shall discuss what next in that meeting.

Without pre-empting the results of that meeting we discuss an idea that has been raised by several members of the team – having and using shared web-space for our work. 'Shared web-space' below is our term for a vision of pupil and school connectivity (see <http://educmath.inrp.fr/Educmath/recherches/projets-de-recherche/connectivity>) possibly using course management systems such as Moodle (<http://moodle.org/>) and on-line collaboration tools such as Elluminate (see <http://www.illuminate.com/>). With shared web-space pupils, teachers and university staff could engage in a number of activities.

Tasks

Teachers (and even pupils) could place tasks on the shared web-space for others in the project schools to take on, amend and contribute solutions to. Such a service is available on Nrich (<http://nrich.maths.org/public/>) but an advantage of a local space is that it could be geared to the locality, participants would almost certainly feel greater ownership and thus involvement and we could input into the design of the web-space, not just input tasks into an existing design.

Tasks could also be designed to bridge Years 6 and 7, i.e. starting in Year 6 and continuing into Year 7. This has obvious problems since Year 6 pupils usually go to many different secondary schools but the potential to contribute something to the problems of primary to secondary transition is a great challenge that should not be ignored.

Data generation

Data handling was the mathematics focus of our project and the lessons in the Harrogate triad included pupil generated data. Pupil generated data has great potential to motivate pupils than data simply given to the pupils because pupils will feel an ownership of the data. Pupils are also likely to be able to make greater sense of the mathematical meanings of statistics on data they are contributed to generating. The range of possible topics for data generation is huge, from evaluations of pizzas (as with the Harrogate triad) to details of pupils (hobbies, favourite TV shows etc) to physical information (rainfall). Shared web-space would provide a relatively easy means to input data from a number of pupils/schools into one dataset for later analysis.

Competitions

As well as collaboration children enjoy competition. Nationally competitions such as *Maths in Motion* (see <http://www.mathschallenge.co.uk/>) already provide forums for KS2 and KS3 to compete against each other in highly motivating on-line competitions with a lot of mathematics in them. Local shared web-space could facilitate involvement in this and locally designed on-line competitions.

Special lessons

Shared web-space would provide means by which real-time lessons could be run by a teacher in one school and pupils in many different schools. For example, an advanced skills mathematics teacher in a secondary school with a brief to work with primary schools could conduct lessons with high attaining pupils from different primary schools.

Regular teacher observation/feedback

Now we get to an exciting way that technology harnessed to a shared web-space could lead to regular teacher observation and feedback – a video camera with suitable audio recording equipment strategically and permanently placed in each project teacher's main teaching classroom. This would enable recordings of many lessons to be recorded and stored. Other project teachers would watch the lesson at the time of the lesson or in free time after the lesson. Feedback could be stored on the web-space and/or social networks enabled by the web-space.

This facility would not completely overcome the various problems concerned with teacher time alluded to above in visiting other schools but it certainly appears that it would go a long way towards regular and frequent mutual observations and feedback.