Teacher Mediation of Subject Learning with ICT: a MultiMedia Approach

UNIVERSITY OF CAMBRIDGE
Faculty of Education

SUPPORTING PROFESSIONAL DEVELOPMENT IN THE SECONDARY MATHEMATICS CLASSROOM USING THE T-MEDIA DIGITAL VIDEO RESOURCE

Final Report to NCETM

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Supporting Professional Development in the Secondary Mathematics Classroom Using the T-MEDIA Digital Video Resource

Executive Summary

This report documents the trialling of an interactive CD-ROM produced by the collaborative T-MEDIA (*Teacher Mediation of Subject Learning with ICT: A Multimedia Approach)* project and production of a toolkit, commissioned by NCETM, designed to guide teachers' use of the materials within mathematics departments of schools and colleges. The T-MEDIA resource contains a video-based case study of teaching and learning about straight line graphs, using data projection technology, laptops and graphing software. The resource is designed as a tool for professional development through stimulating reflection and debate rather than presenting a model of best practice.

To create a toolkit that groups of teachers could use as a professional development tool, two trials were carried out. The first trial took place at a high-attaining 11-16 comprehensive intake school. Three mathematics teachers and a facilitator used parts of the resource, discussed the implications of what they had seen and potential alternatives, then planned and taught a lesson as a response. They observed each other's lessons, and gave feedback afterwards.

The structure that was created for the first trial was then used in a low-attaining 11-16 comprehensive intake school. Two mathematics teachers and a facilitator participated in the second trial. The focus for the first trial was pedagogic strategies for motivating and supporting pupil participation in whole-class activity, while the second trial had a particular focus on developing wider use of available technology, for example the interactive whiteboard (IWB) and online resources on laptops. The teachers were all extremely positive about having participated in the trials and wanted to continue using the T-MEDIA resource and discussing the issues arising. They each made significant changes to their practice for the lesson that they prepared and some of the teachers planned to change their usual practice as a result. The results of these two trials informed the creation of a toolkit that was trialled at a third school.

The toolkit was developed to support teachers to run their own INSET course without recourse to an external facilitator. Derived initially from the pilot study model, and modified by teachers' comments, it was designed for teachers to use the T-MEDIA resource flexibly. The toolkit consists of:

- An introduction to the T-MEDIA resource;
- Notes and a flow diagram illustrating how the resource might be used in an iterative way to support development of teacher thinking and classroom practice, plus technical information;
- A screen resource list illustrating potential routes through the resource;
- A briefing sheet for Senior Management Teams.

The toolkit was trialled in the mathematics department of another low-attaining 11-16 community college. All four members of this collegial department were experienced teachers. The teachers were given the toolkit and observed as to how they used this in conjunction with the T-MEDIA

resources over the following 10-day period. Modifications to the toolkit were made in the light of both the researcher's observations and the teachers' comments.

In essence, the teachers worked together for the first orienting session and found it helpful to then work independently to get to know the T-MEDIA resource and reflect on how they could use their own facilities and resources. They then split the second session into two parts, at first meeting all together (considering some clips) and then later as two pairs. Each pair took a different route through the resource, according to the needs of their pupils. In pairs, they reflected and discussed the related clips, and used this to consider issues related to planning their own lesson. They remained in pairs for the lessons, observation and feedback sessions. There was a common focus on use of online games to increase pupil motivation and support collaboration.

The teachers in this trial found the toolkit user-friendly and helpful in guiding them through the resource. Minor modifications were made as a result of their feedback. They felt that the experience helped encourage them to:

- Find out more about the software they already had
- Seek funding to update and buy appropriate hardware
- Explore new ways of using their own technology
- Experiment with different pedagogical techniques in the classroom
- Consider further training for particular software programs.

In all three of our trials the resource itself acted as a powerful stimulus for reassessing pedagogical thinking and practice – by teachers with a wide range of different levels of experience and needs – and the perceived effects were dramatic. *Participants were keen to commit to continuing the process over the longer term and extend it to their colleagues – and it is this collaborative, teacher-led, dialogue-based model of CPD that the resource and toolkit are designed to promote and support.* Of critical importance for the success of such CPD is a willing coordinator and management support for the process, including teacher release time. The SMT briefing sheet was developed in order to inform school leaders succinctly of both the benefits and costs of what is involved. Trials indicated too that any logistical and technical constraints need to be carefully identified in advance and addressed in order for the process to run smoothly.

Introduction

The T-MEDIA[1] *(Teacher Mediation of Subject Learning with ICT: A Multimedia Approach)* research project produced an interactive CD-ROM containing a video-based case study of teaching and learning about straight line graphs, using data projection technology, laptops and graphing software. Designed as a tool for professional development, the resource aims to *stimulate debate rather than present a model of best practice*. It illustrates how one secondary mathematics teacher[2] exploited the technologies to develop learners' understanding of the concepts of intercept and gradient – in a real classroom with students across a wide attainment range. Uniquely, the research team collaborated with the participating teacher and a colleague[3] in critically reviewing the video and other data and jointly refining (sociocultural) theory to describe strategic use of technology. The materials include analytic commentary from participating teachers and researchers, points for reflection and discussion, suggested alternative approaches and discussion of the 'added value' of the technologies. The resource is hosted on the NCETM portal[4] and is also available to educators on CD-ROM at cost price via the research team's publications website.[5]

This report describes a follow-up project commissioned by NCETM, involving case studies of trials with the resource carried out in three Cambridgeshire secondary schools between November 2007 and March 2008. The aims were

- to develop, trial and refine a 'toolkit' of guidelines for use of the resource as a tool for supporting mathematics teachers' professional development – concerning either pedagogical approaches (such as the use of classroom questioning) or effective uses of ICT;
- to document short case studies of trials with the resource and the toolkit, and perceived effects on pedagogical thinking and/or practice.

The toolkit helps users of the resource to understand quickly what it offers and how they might use it to support professional development. It offers some suggested pathways through the resource and shortcuts the process of exploring it in detail. In the next section we describe two school trials of the procedure we developed for using the T-MEDIA resource to support professional development. These trials underpinned our development of the toolkit; its design and subsequent trialling in the third school are described in later sections of this report. *(Key findings and quotes from the teachers have been highlighted throughout via the use of blue font.)*

[1] The T-MEDIA project was carried out by Sara Hennessy (Project Director and Lecturer in Teacher Development and Pedagogical Innovation) and Rosemary Deaney (Research Associate) and funded over 30 months in 2005-07 by the UK Economic and Social Research Council (RES-000-23-0825).

[2] Sarah had taught for 8 years and was Head of Mathematics at her 11-16 village college. She had experience of mentoring and training in the UK and in South Africa.

[3] Hilary had taught for 3 years at the same college and mentored newly qualified teachers. She was interested in taking forward the use of technology in her teaching.

[4] http://www.ncetm.org.uk/Default.aspx?page=13&module=res&mode=100&resid=7045

[5] http://www.educ.cam.ac.uk/research/projects/istl/. The T-MEDIA final report is also downloadable there.

Report on Trial 1

by Mark Dawes, AST

Background

The initial trial of the resource took place at a village college in Cambridgeshire. The teachers involved were Mark (who acted as co-ordinator and authored this section of the report), James, Joanne and Anna. Anna was an NQT, James had 9 years of teaching experience and Joanne had taught for more than 20 years. Joanne and James frequently used a transmission style of teaching, while Anna was a connectionist teacher.

The school is an 11-16 comprehensive school, with specialisms in sport, MFL and vocational education, and has 1200 pupils on roll. In 2007 71% of Year 11 pupils gained 5 or more A*-C grades (including English and Maths) at GCSE. The mathematics department had access to an ICT room. All mathematics classrooms had data projectors and half of them had interactive whiteboards. Of the teachers in this trial Anna and Mark had interactive whiteboards and were experienced users. James made frequent use of a data projector. Joanne occasionally used a projector but was more confident with a non-interactive whiteboard.

Introductory Session

The aims of the session were to explain to the teachers the background to the creation of the resource, to give them an overview of the materials that feature on the disk and to watch one video clip and look at the accompanying lesson plan to provoke some initial interest and brief discussion.

I stressed that the materials were not presented as 'best practice', but as ordinary lessons being taught in a local Cambridgeshire Village College by the usual class teacher. The focus of our discussions could be on aspects of pedagogy or on the use of ICT.

The contextual information that is provided on the disk was very useful. The teachers were keen to know about the background to the lesson and information about the class. They were surprised at the wide range of prior attainment in the group (Level 3 to Level 6) and noted the topics that the class had studied recently, that there were 21 pupils in the class and the extent of ICT resources that were available.

We watched Clip 1.1 (teacher introduces an online co-ordinates game 'Connect 5' using a data projector and tablet PC which is handed round for pupil input; pupils continue playing game in pairs on laptops). The teachers gave their impressions, both of technical issues surrounding the clip and the teaching and learning examples that were displayed within it. Examples of the former included frustration at not being able to see what the rest of the pupils were doing while the teacher spent several minutes talking to one pair of pupils. It was acknowledged that it would not be desirable to watch the whole lesson because it would time consuming and more difficult to isolate key points.

The initial intention had been for the session to focus on technical issues such as the composition of the class, the structure of the resource and for decisions to be made about which clips to focus on for the next discussion session. The focus changed as the session unfolded because the teachers were very stimulated by the content of the lesson and the decisions taken by the teacher in the clips and wanted to begin their discussions immediately.

James was very keen to establish exactly what the outcome of the project would be. I explained that in the next session we would watch a video clip, have a conversation about what we had seen and would decide what we wanted our response to the video clip to be. The response would be framed as part of a lesson that would be observed by other members of the group. If we disagreed with something we saw then we might decide to use a particular resource from a clip (e.g. 'Connect 5') but in a different way, or to teach a different topic entirely but to use some of the ideas that we have talked about. I made it clear that the lesson would not have to use anything directly from this resource, but could instead focus on implementing things we had talked about in the sessions.

The teacher commentary (to the right of the video clip) mentioned 'efficient use of time'; part of the discussion focused on whether using a tablet PC to allow pupils to play the 'Connect 5' game did save time, or whether alternatives, such as having two teams of pupils playing on an ordinary whiteboard would be more efficient. Concerns were also raised about the length of time the class spent on playing the game (as shown by the time code on the video) and whether all of the pupils were fully engaged and benefiting from the task. The conversation moved to discuss how to play this as a whole-class activity on an ordinary whiteboard (with a grid and axes projected on it), rather than having pairs of pupils playing at computers. Anna suggested that this could allow at least half the class to take active part and could include an element of competition. Joanne wondered whether pupils naturally chose to use the first quadrant and whether they aimed for horizontal and vertical lines rather than for diagonal lines. It was felt that the board pens could be passed from pupil to pupil like a baton, adding to the competition involved and that the feedback given by the computer (as mentioned in the teacher commentary) would instead be provided by the rest of the class.

This initial session ensured that the teachers understood what we were aiming to achieve, gave them an overview of the materials on the resource (including the various commentaries) and an overview of the composition of the classroom. It left the teachers looking forward to the next session.

Using the resource

The original idea had been for the teachers to be able to spend two hours using the resource and discussing issues from the clips. For practical reasons this was split into two separate sessions.

At the beginning of the second session the teachers decided not to have ICT as their focus, because the ICT that they had available was not compatible with that which was used in the video clips. I then reiterated that the idea is not to make wholesale change to our own practice, but to choose a particular thing to focus on in our 'response' lesson.

We watched Clip 3.1 (where a pupil is asked to draw the line $x = -2$, another pupil is asked a question he can't answer and passes it over to another member of the group). Teacher commentary was available with the clip but the teachers wanted to ignore this and instead focused on their own discussion.

Focus 1: Managing whole-class questioning

The discussion began with ideas of ways of helping pupils who cannot answer whole-class questions. It was noted that the teacher was happy to allow a period of silence while the pupil thought about the question and that allowing the pupil to choose which of their peers they would pass the question over to helped to create an ethos where pupils who are 'stuck' do not ask an authority figure such as the teacher or teaching assistant, but can ask another pupil. The teachers all

considered how they manage this in their own classrooms and shared their thoughts. This was a valuable period of reflection.

I asked why the teacher had told pupils not to put their hands up at one point; this led to further reflection from the teachers and a sharing of strategies and ideas.

The session ended with James saying: "I have thoroughly enjoyed the chat", which met with agreement from the other teachers. The discussion was not only enjoyable, but very reflective and productive. At several points the discussion was moved on by myself. The role of the co-ordinator/facilitator seemed to be a key one.

Use of the Theme Map

The next meeting began with viewing the Theme Map screen of the resource. It was felt that the two clips we had already seen could be linked in to several more sections of the Theme Map and that an expanded map would be useful for teachers wanting to use the resource to focus on a particular pedagogical issue. In this session it had been intended that we would watch more clips, but in the event the Theme Map alone proved to be an effective springboard for our own discussion.

Focus 2: Motivation and involvement

James expressed frustration at seeing some of his pupils behaving in an excited way when with their friends but being very restrained in lessons and barely participating. He was looking for a way to motivate the pupils more in his lessons. This led to a big discussion about the difference between motivation and involvement. Anna pointed out that it is relatively easy to measure involvement, but much harder to measure motivation. For example, a pupil who has been told he can sit with a friend as long as he answers one question each lesson is not motivated but he is involved. It was finally agreed that teachers can directly influence the involvement of their pupils, but that this could then have a positive effect on the pupils' motivation. Different methods for attempting to involve pupils were discussed and the teachers all planned to focus on this in their lessons.

The session ended with comments from the teachers about how much they had enjoyed the discussions. The resource was felt to be a helpful prompt.

The Lessons

Joanne's Class

Year 9 Set 9 (of 10)

Aims of the lesson

Pupil learning objectives
To practise different methods of calculating percentages of numbers, using mental methods.
To learn how to use a calculator to calculate percentages of numbers.
To carry out a game.

Pedagogical aims
To ensure that everyone was involved in the whole-class work.
To ensure that the girls were more involved in the lesson than usual.

Joanne did not want the pupils in her classes to feel anxious about their mathematics and therefore during whole-class work she did not usually call on pupils who did not have their hands up. She noted that this can mean some children do not take part during certain parts of the lesson and wanted to make a change to her practice so all pupils would be involved in the lesson but without anyone feeling they were being singled out or put under pressure. She also noted that the girls in her class participate less frequently than the boys and wanted her lesson to address this too.

The lesson

Joanne recapped the mental methods of working out percentages. She then issued each pupil with a numbered card, at random. On the screen 32 questions were projected onto an ordinary whiteboard. They were all "percentages of" questions (eg 20% of 120). Two pupils were given board pens to use. They had to write up the answer to the question corresponding to their number card and could then pass the pen to anyone else in the class for them to write their answer. As a way of ensuring that everyone was still involved the pupils were encouraged to check the answers of other pupils. This took 2¾ minutes. When everyone had participated, the pupils were allowed to come up and put in other answers (there were more cards than pupils) or to make changes to answers they thought were wrong. The only error was corrected by the pupil who had written it up originally.

Joanne then explained to the pupils how to use a calculator to work out percentages. She went through this step by step and wrote on the board the method she wanted the pupils to use. The pupils answered questions, checked these with the teacher and moved on to other questions. The atmosphere was very positive and the pupils gently joked with Joanne about arithmetical slips she made.

Comments

The task at the beginning of the lesson fulfilled Joanne's desire to involve everyone in the lesson, to encourage a sense of teamwork and to do all of this very quickly and efficiently. The rest of the lesson was in a transmission style of teaching, with the teacher explaining what to do and how to write it down and the pupils following the instructions and answering questions.

Discussion with Joanne

Joanne explained that the boys in the group are very self-confident but that in this lesson she particularly wanted to get the girls participating in the lesson and putting their hands up. In the initial task everybody was involved because they all had to go up to write on the board. The idea was that everybody had a question to answer, that they could take time to work out the answers because they were handed the pen when they put their hand up, and could then look for errors in the other answers that had been put up. The only incorrect answer was corrected by the pupil who had written it up. This was 1% of 110. Joanne said that she shouldn't have selected two numbers at random to start the task off because those pupils were put on the spot. Next time she said she would start with two volunteers. The class will repeat the game next week and they will try to beat their class time. As an extension, at the end there will be extra numbers for volunteer pupils to do. Joanne was very pleased at how the lesson went.

I asked what from our group meetings had influenced the lesson. Joanne referred back to the discussion about enjoyment, motivation and involvement. "This definitely got everybody involved. Most of them seemed as if they quite liked doing it, but I don't know – once you're down to set 9

the motivation and enjoyment are quite difficult. None of these pupils are going to go on to do maths as a major subject later on." Joanne added "I wanted it to be something they could succeed at – to give them the positive feeling that 'this is something that we have been doing and yes I can do it'."

Joanne referred back to Clip 3.1, where a pupil had passed his question on to another member of the group, and our discussion about whether this was a strategy for him to avoid thinking or working out an answer, or a useful strategy (Focus 1). Joanne deliberately wanted everyone in her class to answer their own question, but then because it wasn't possible to identify who had answered each question at the end of the task any *mistakes* could be corrected rather than a *person* being corrected.

Mark and Joanne discussed ways of dealing with a situation where the pupil cannot work out the answer even with help from friends or extra time and possible strategies for ensuring the pupils searched for errors while they were not up at the board.

For the rest of the lesson Joanne felt that there was more participation in the lesson by the girls than is usual. She thought that because they had done the first activity well and had succeeded at it, they were more confident during the rest of the lesson.

James' Class

Year 7 Set 3 (of 5)

Aims of the lesson

The ***mathematical aims*** were to practise multiplication and division.

James wanted to have a particular ***pedagogical focus*** on groupwork, pupils supporting each other and on pupils asking questions.

Lesson notes

The pupils were seated at six tables, with five on most tables and one group of three. Coloured sheets were issued to each table (different colour to each table). Every sheet was different. The pupils' sheets assigned them to two groups, their original group and a new group in which they were the only representative of their original group. James described the format of the lesson to the class in terms of 'rounds'.

In the first round they carry out two calculations in their original group. In the second round they carry some of their answers from the first round to their new group. They move seats and carry out two calculations. For the third round they return to their original seats with some answers and carry out two more calculations. There would then be a final class answer. This answer would depend on calculations carried out by every member of the class. A small mistake by an individual could result in the wrong answer for the whole class.

James wanted the pupils to carry out groupwork during the lesson, but did not want anyone to opt out of participating. He made it clear that every pupil should participate: "If anyone makes a small mistake with their digits then the class word won't work. So every single person has an important role", while ensuring they were aware that this was not designed to put individuals on the spot:

"You are going to work out some answers and you must get help if you aren't sure or must help other people if you can do it. You will need to work with other people, sometimes with people you don't normally work with." He reiterated: "What will happen if there are people in the room and they make a little error because they haven't concentrated or haven't asked their mates for help?" Pupil: "It will mess it up for the whole class". "This is a big responsibility, so I am going to want you to check that your answer is correct but also that your friends' answers are correct too."

The pupils worked together and checked their answers carefully. It became clear that there would not be enough time to complete the final round, so James said: "We aren't going to get this finished today, but I want us to be able to complete it because you are having tons of fun." A pupil murmured "yes we are!"

At the end of the lesson James said to the whole class: "I am going to ask one question – I don't know yet who I want to answer it, so everyone needs to have an answer to the question. 'How many people helped you and how many did you help?'" Answers ranged from 3 to 9.

Discussion with James

James was pleased with the way the pupils had responded to the lesson and their mathematical work. He referred directly to the discussions that we had had. "I used this as an opportunity to think about and tweak the idea for something I have been wanting to do for a while. But our discussions helped to give me the impetus to set this up."

The conversation returned a number of times to the previous discussion about group work [Focuses 1 and 2]. In the discussion, prompted by a video clip, we had talked about the drawbacks with different approaches. If pupils genuinely do not know an answer they may be upset at being asked directly, but if they work in groups there is an opportunity for pupils not to participate because each individual's involvement is difficult to measure directly. James wanted a way to ensure that no-one in the class slacked off but that they could still access the pedagogic value of working in a group. He called it 'cutting the group two ways'. [There are similarities to an 'emissary' approach employed in some primary school classrooms.] James: "One of the things that worked really well was cutting the group two ways. I think the key issue was that every single person had a role to play and it would get messed up if someone made a mistake." Yet every pupil had a support structure in place, in the form of their groups, to ensure they were able to feel confident about their work. The pupils did check each other's work carefully and argued about wrong answers.

Three issues recurred during the discussion. James was worried that he had not directly used the resource to plan his lesson. I explained that this was not a problem because it was very clear that he tried to reflect in his lesson some of the issues we had discussed as a group. He had seen it as an opportunity to try something very different from his usual practice and to take some risks. The second point was that it had been a very valuable experience for the pupils and for him. He was pleased with the way the pupils responded to the groupwork and with the way he had devised the lesson and implemented it. The tables in the classroom had been rearranged for this lesson; the pupils do not usually work in groups larger than a pair. James intends to disseminate this resource to the rest of the department and to reuse it himself in future years. The third issue was the amount of time it took him to set it up and to ensure there were no errors. He thought it was unlikely he would have the time to do anything similar with other topics. He wondered whether it would be feasible to use ICT to automate the process.

James had been a valuable member of the discussion group and used this project as an opportunity to try something that was very ambitious and very different from his usual practice.

Anna's Class

Year 8 Set 2 (of 5)

Aims of the lesson

Mathematical aim: To use Fibonacci in different situations
Pedagogical aim: Pupils working in groups and being excited about their maths

Lesson notes

Anna explained that each group had five envelopes which they would need to work through in order. The pupils would need to indicate to her that they had finished each quest before being given permission to move on the next one. Hints were provided in the plastic bag but the pupils were warned that they should only use these if, as a group, they decided they were stuck and needed some help. Anna: "Puzzle number 6 is at the front – you can only get this if you have proved yourself worthy by answering the previous quests!"

Anna asked if there were any questions. A pupil asked: "Do we work as a group?"
Anna: "Yes – this is about mathematical discussion and group work."

The six tasks looked at different aspects of the Fibonacci Sequence and gradually got more difficult. The pupils were very excited about moving on to the next task. All of the pupils were on task and worked together well. The only hiatus was when they were waiting to tell Anna they had finished a task.

Discussion with Anna

Anna explained that she had used this as an opportunity to do something she had not tried before. In particular she was interested in whether the pupils would be able to have "good discussion". She said that the inspiration for the lesson came out of the third session where we discussed collaboration, involvement and engagement (Focus 2). She wanted the lesson to include competition, collaboration and a game (as in Clip 1.1). As the planning unfolded, for time reasons she dropped the collaboration between the groups, but instead had the collaboration inside the group. The element of competition for the pupils was for them to show that they were quick enough and competent enough to do the final task in the quest! They didn't realise that this was the extension work, because the way it was presented made it a challenge they wanted to meet.

Anna identified a couple of problems with the lesson, including one activity that did not lend itself to being completed at speed and a group in which one pupil was desperate to continue working out his ideas, while the other pupils all wanted to request a hint. She also mentioned that some pupils were happy to ask her for help, but not to use the hint that she had written!

Anna explained that it was the group discussions after watching the video clips that had really been important. "I am not sure that the video had a prime role. I think the process, the way it was set, was fantastic, but the starting point could have been something else as well. But it was a lovely starting point. The sharing of the ideas in the group were what produced the lessons. If you just gave me the CD and told me 'be inspired by the CD, teach a lesson based on what you see on the CD,' I'm not sure the outcome would've been – well it wouldn't be the same, would it. … I'm not sure how much I would have changed." She also described how "The resource is the trigger – it triggered the conversation and the conversation triggered the lesson."

The Final Discussion Session: Implications for departmental practice

I began by asking what we should do next. The whole of the meeting focused on ways of embedding this project within the practice of the department.

Various ways of embedding this as a standard part of departmental development were put forward, including making use of departmental meeting time, of training days and the school's existing 'peer observation' process. Issues related to the length of time it took to plan such innovative lessons were dealt with by Anna, who felt that she had got three lessons out of observing the rest of us, so overall she had gained great lesson resources in return for her involvement.

James pointed out that the best way to formalise the innovation of using a resource like this one would be to have it as a performance objective for every member of the department. Now that four members of the department have participated in this it would be possible for them to act as co-ordinators for new groups involving other colleagues.

At the end of the session each teacher commented how much they had enjoyed the project and how much they had got out of it.

Anna said: "The whole process is very, very positive towards better teaching and better learning and I think if we don't do that we are missing out on a lot of opportunities to better ourselves as teachers."

Final Comments

The first phase appeared to be very successful; the teachers were very positive, they planned lessons that were markedly different from their usual lessons, committed a large amount of their own time to the project and produced lessons that were very well received by the pupils.

There were a number of key elements that helped the project run smoothly:

- The teachers involved are all committed to their own professional development and wanted to participate in this project.
- The role of the co-ordinator is key; Mark was able to select appropriate clips and to keep the discussion moving when it stalled.
- Support from the Head of Mathematics and Senior Management to allow the teachers to be covered to release them for meetings.

Implications for Trial 2

The first trial proceeded smoothly. The second trial was thus planned to follow a similar pattern, except that, for logistical reasons, the second and third hours (the main session) happened consecutively rather than with a break between them. In the first trial the teachers wanted to focus on pedagogical issues. The mathematics department at the second school was examining their use of ICT at the time, so the focus for the lessons was expected to be ICT-based.

Report on Trial 2

by Mark Dawes

Background

Trial 2 took place at a different village college in Cambridgeshire. Mark again acted as co-ordinator, but only participated to carry out that role. The other teachers involved were Callum, an aspiring head of maths, and Matthew, an experienced teacher who is new to the school. Both teachers use interactive whiteboards in the majority of their lessons.

The school is an 11-16 comprehensive school, with a specialism in sport, and has 900 pupils on roll. In 2007 37% of Year 11 pupils gained 5 or more A*-C grades (including English and Maths) at GCSE. Callum taught ICT in addition to mathematics and was an experienced user of an interactive whiteboard. His classroom was an ICT room. Matthew used an interactive whiteboard in every lesson and was becoming more confident in its use. He did not have access to a computer room for his lessons.

Introductory Session

In the initial session (of one lesson) I introduced the project and the CD-ROM; in particular it was stressed that:

- the lessons are not intended to be examples of 'best practice'
- this was a genuine class of pupils
- they have a number of visitors and a video camera in the classroom
- the pupils make mistakes
- there is other information attached to each lesson and each video clip

We watched Clip 3.1 (in which Autograph is projected, the teacher has explained how to draw the line $x = 3$ and then asks a pupil up to the front to draw the line $x = -2$ on the projected axes).

Callum thought the clear structure and the use of Autograph engaged the class but pointed out that squared paper on an interactive whiteboard would have sufficed, making the use of Autograph irrelevant. Matthew thought that it was "pretty low-tech". There was agreement that the technology speeded up drawing the axes and the graphs but that there was nothing technically interactive in the clip. Matthew identified that in his own teaching he does not get pupils to come up to the front to interact with the board. This is something he wants to start to do.

Using the resource

I began this session (a double lesson) by reminding Callum and Matthew of the purpose of the project and stressed that the key thing was the conversation we had after watching some clips rather than trying to emulate the teaching in the clips. This conversation should inspire a response in the form of a lesson that will be taught by the teachers and observed by the others.

Both Matthew and Callum mentioned how much they had enjoyed the first session and that it would be particularly exciting for the rest of department to be able to participate in a similar project later in the year. Matthew said: "It would be great to use something like this in the department. We had a department meeting last night and there was nothing like this." Callum added: "I asked the head of department if we could do this in the summer term."

We watched Clip 5.1, where the pupils were asked to match up cards of equations of lines and their graphs. Callum and Matthew commented that the teacher was very heavily involved in setting the agenda in the lesson. For example, in the clip the teacher told the pupils to start with the gradient, to draw a triangle, then to look at the y-intercept. The pupils were told that the gradient was "up divided by along", she told the pupils "the key things to look for …". The Trial 2 teachers considered that this involved lots of 'telling' rather than involving the pupils. Callum commented that while the ICT helped the pace, it was not interactive and the pupils were not involved in using the board.

Focus A: Supportive questioning; eliciting and guiding

Matthew identified that when, in group work, the pupils were really very unsure of what they were doing, the teacher had not told the pupils anything, but had used specific questions to elicit the answers. "It was quite nice the way she led them through to eventual success."

The teachers wanted to make it clear that the teacher on the video was clearly very skilled, and that their criticism was focused on the unexciting use of the technology. We concluded this section by reading the various commentaries on the lesson.

Focus B: Encouraging pupil involvement

We then watched Clip 5.2 (in which a table of values was created and a graph drawn by hand). Callum thought it was ideal that the teacher was very clear in all her instructions. This meant she would not "lose" anyone and they would all be able to follow what to do. Matthew stated that this lesson "was not rocket science". There was nothing interactive and when he tried to think how he would teach this topic, he decided he could see himself doing this in exactly the same way. Callum decided we should discuss how it would be possible to teach in a different way.

Matthew said that he found it interesting that every time the teacher asked a question she seemed to be prepared for the particular wrong answers that the pupils gave. He gave an example of how, when a pupil "blurted out a wrong answer, the teacher coaxed him towards the right answer". This linked in with the 'eliciting' that Matthew had commented on earlier.

At various points during the discussion I moved the conversation on (particularly when it began to flag). For example, a very fruitful discussion about the nature of the guidance provided by the teacher followed one such intervention. I pointed out that the teacher had told the pupils: "the best thing to do here is to actually draw three points… so what I'd like you to do is to write down the numbers 1, 2 and 3 [for x]". Callum picked up on this and thought we could ask the pupils which values to choose rather than telling them. Matthew usually asks his pupils to make a table of values with five values that includes zero and some negatives.

Callum continued to consider how ICT could be used effectively in this lesson. He wondered whether he would ask the pupils to come up to the board to plot points.

Matthew picked up on the text in the commentaries: "I really liked her questioning and taking a wrong answer. Is that the funnelling?" "What's the technical term for taking a wrong answer and pushing pupils to the right thing?" We used the glossary on the CD-ROM to check.

Summary of the discussion

The discussion was extremely valuable. As it progressed, more interesting ideas were put forward, some of which were novel and others of which expanded on something that had already been mentioned. It did not seem likely that this level of engagement would be achieved by a single teacher working by themselves. Indeed, a group size of three would seem to be a minimum. It was useful that the teachers had different levels of experience and different attitudes because this added to the richness of the discussion.

The particular issues that Callum and Matthew thought were key:

- Whole class work was not interactive
- Group work was interactive, using cards
- The use of ICT did help the pace of the lesson
- The highly structured nature of the lesson; they thought it could be left a little more open
- Developing ideas by funnelling questions
- Using pupils to model ideas, rather than the teacher doing it

Lesson Planning

Callum and Matthew both decided to teach their response lesson to one of their Year 7 classes. They had just over a week to make use of the lesson of cover that was available for preparation. Both classes were starting a topic of negative numbers.

Callum's lesson took place in the computer room (where the class habitually has their mathematics lesson), with enough computers for each pupil to work individually and a SMARTboard and projector. Matthew's lesson took place in the usual classroom, in which the pupils sat in rows and there is a SMARTboard and projector.

Lessons

Callum's Class

Year 7 Set 3 of 3 (Callum described the pupils as being "low level 3 to mid level 4". Of the 7 girls and 6 boys in the group there was one pupil with ADHD and one with EAL.) Mark and Matthew observed the lesson.

Lesson Aims

Mathematical aims:
Adding and subtracting using a numberline and then extending this to include negative numbers.

Pedagogical aims:
Using the IWB with pupils, so they can interact with it in front of their peers.

Using MyMaths for the first time with pupils working individually at it to improve their motivation and to work at their own pace.

Having seen ICT used in a number of ways in the video clips, Callum wanted to try out some different uses of ICT in his own lesson. He also wanted to ensure that all pupils were involved in the lesson.

Lesson Summary

Pupils moved their chairs to sit close to the IWB. They were shown some positive and negative numbers that could be moved individually. A volunteer was asked to put the numbers in order. A time limit was given and the boy who moved the numbers around completed the task within the time. He was told "pick a girl" and the chosen girl did the second set of numbers (successfully, against a smaller time limit). She then chose a boy who successfully completed a third, slightly harder task.

The pupils were then shown how to use a horizontal numberline (running from -5 to 5) to add and subtract. Callum demonstrated 3+2 by drawing a circle around the 3 and then curved arrows that jumped up two places to 5.

The pupils were then given a sheet of questions to answer, which they did very quickly. The next slide had a big arrow pointing to the right with 'add' next to it and one pointing to left with 'subtract' next to it. The pupils were shown this and then asked to complete some subtraction questions. None of the questions involved subtracting a negative number. Callum went through the answers on the board, saying "I will do the interactive bit to speed things up."

The pupils were then told the login details and were asked to load up MyMaths and to find the file 'Negatives 1'. Most of them needed help to type the URL correctly. They then, as intended by Callum, began to play with the program to find out how to use it. In most cases they managed to work out how to navigate through the 10 sections of the resource. One pupil was unsure how to find the difference between -7 and 7. Other pupils had had similar issues but they just clicked on to the next section without persevering with the difficult questions. Those that were helped by one of the teachers seemed to get more out of the resource. The final section was a 'beat the clock' game in which pupils had to answer as many addition and subtraction questions as possible in 2 minutes. I watched one who typed in "3" for every question and then clicked 'mark it', without reading the question. He scored 1 out of 26.

Reflection

Callum had attempted to involve students more than he perceived the video had portrayed. He also recognised that the pupils are used to using IWBs at primary schools, so this is something that can be built on at secondary level. This was a reaction to the approach on the video where the department had deliberately decided not to buy IWBs but to use tablet PCs and a projector instead. During the lesson the pupils were very happy to go up to the front of the class and to use the IWB, even if they made mistakes. As Callum put it: "You've got to work very hard at creating that environment where it's OK to get things wrong; it doesn't matter." This linked in with some of the discussion about the video clips in which the teachers identified that it was helpful to the rest of the class when a pupil had struggled with their maths but had been guided through by the teacher to a correct answer (Focus A).

When the pupils were answering questions, Callum had told them "you might want to draw a numberline". After the lesson Callum referred to this: "You can't tell them what to do. You can

give them ways of doing it and tell them – whatever works for you." (Focus B). This was a direct response to some of the discussion we had while watching the video clips where Callum and Matthew had identified that the pupils were being told exactly how they should approach a task and how they should work things out. Here the pupils decided where to sit, and then some of them drew a line, while others looked up at the board and referred to the numberline they had used previously in the whole-class work.

Callum explained that he wanted the pupils to explore the MyMaths work themselves, so he could see how they reacted to it. He said "My problem with what I call 'Computer-Based Training' is that kids go 'click, click, click' and say 'I've done it, sir' and persuading them to go back is very difficult." Callum reflected on the way the pupils had reacted and decided that it would have been more effective if he had used it as a whole class, perhaps in a competitive way. He thought that he could ask pupils to carry out specific tasks (eg answer three questions from section 5 and then three from question 7), writing down their answers so he knew that they had done it.

Callum finished by saying: "What the project made me think about is 'how do I want to build that interactivity [of the IWB] and why am I doing it?'"

Matthew's Class

Year 7 set 1 of 3 (17 girls and 15 boys)
Lesson observed by Callum and Mark

Lesson Aims

Mathematical aims: Pupils to be able to add/subtract positive and negative integers.

Pedagogical Aims: Ideas to be elicited from the pupils rather than given by the teacher. Pupils to use the interactive whiteboard. Pupils to carry out pairwork and discussion.

Matthew recognised that his lessons were very teacher-led. He wanted to try out some very different things from his usual practice, including having pupils discussing ideas and coming up to use the interactive whiteboard.

Lesson Summary

The first part of the lesson consisted of recapping the previous lesson's work on rounding decimals. This had been done with a numberline. Matthew elicited from the pupils that the numberline could be extended to the left to display negative numbers. He then asked them to discuss with their partner how they could use a numberline to carry out calculations involving adding and subtracting negative numbers. The pupils needed to be able to explain it to someone at primary school. When Holly had a good idea Matthew referred to this as the "Holly Rule" and later asked her to go up to the board to explain it. Holly used the interactive pen, and wrote on the board as she talked: "You start at 2 and go up by 5 and you get 7". Presumably mindful that she was supposed to be presenting to 7-year-olds, she said this in a sing-song 'primary teacher' voice.

Next they used the MyMaths 'Negatives 1' resource as a whole class and finally answered some questions from a textbook.

Feedback discussion

Matthew had engaged very well with the ideas on the T-MEDIA CD-ROM and was extremely keen to further his professional development through the project. He treated it as an opportunity to try something new and was clearly anxious about how well it would work. He told me before the lesson that he was nervous about how it would work because he was intending to try something that was very different from his usual style of teaching. He mentioned during the feedback that he felt under pressure being observed by two other teachers.

Matthew had two interlinked concerns. He wanted the pupils to produce the mathematics for themselves through pairwork and discussion, rather than being told how to do it, but was concerned about the potential for the pupils to misbehave. He returned to both of these issues several times during the discussion after the lesson:

"Because of the behaviour problems I have at this particular school I try and be a quite sort of domineering ringmaster." [I tell the pupils to] "do this activity for 2 minutes, give me your answers [etc]".

"I was going to try to something that was a little bit edgy and a bit different. Instead of me being the ringmaster and dictating from the front … Let's see if I can elicit from them … if they can kind of work this out for themselves."

"It's not a normal way that I teach… I would normally go in, put it on the whiteboard, this is the rule, this is how to do it, do as I say, open your books, do the exercise."

"In order to keep control you've got to keep order from the front … and as soon as you hand over to them you can risk it getting very chaotic."

Later in the discussion he returned to the theme: "I'm a bit conscious as a teacher I'm a bit old-school and I'm so used to standing at the front of the class as a little dictator… do what I say."

Another theme, that has already been alluded to in the quotes above, was how keen Matthew was to adapt and improve his own teaching and his range of teaching styles.

The two main ideas that Matthew had chosen from the discussion that had taken place after using the T-MEDIA resource, were:

- having pupils using the interactive whiteboard
- allowing the pupils to work out new ideas collaboratively

The first of these was as a result of the discussion that took place after watching Clip 5.1, in which Matthew was critical of the lack of interactivity in the lesson (Focus B). The second idea came from the teacher's practice (in Clip 5.2) of funnelling the pupils' discussions and ideas to produce understanding of the content (Focus A).

As Matthew said during the feedback session: "I just wanted a lesson that was very different in terms of eliciting from them rather than me telling the rule and getting them out to interact with the whiteboard instead of it always being me… I wouldn't be too critical of myself in that I did manage to achieve those things and the fact that they didn't go brilliantly … it is a first step."

It was interesting that the part of the lesson that I thought worked best (where the pupils were struggling to find a way to explain how to subtract negatives) was the part that Matthew felt had

worked least well. He thought it was unfair to let the pupils flounder. When I said that I thought the point where the lesson lost momentum was when some pupils were invited up to use the My Maths materials from "Negatives 1" which was far too easy for them, Matthew was initially very surprised. Later he returned to this and said he couldn't believe he had showed them those MyMaths pages because they were obviously (in retrospect) inappropriate.

In the last 5 minutes of the lesson he set them three multipart textbook questions. The first of these involved putting positive and negative numbers in order. Again, he accepted that this was not an appropriate activity and that he should have moved them on to something more appropriately challenging.

This experience strongly highlights the importance of having someone else to discuss the lesson with. While it was valuable for Matthew to plan and teach the lesson, the post-lesson discussion not only recapped the important issues from the lesson but gave alternative ideas and viewpoints to be considered in the future.

Matthew is used to teaching in a particular way because it is safe and easy for him to do. In this lesson he clearly moved outside his comfort zone. He commented on how useful he has found the project.

"I think the whole involvement of this little project, yourself and the videos we looked at last week has been a catalyst to make me take the plunge and try it and I'd have to be a superman, really, to go in the very first time I try it and do a stonking lesson. It's not a surprise that at the end of it we're saying 'yeah you got kids out to the whiteboard yes they interacted with the whiteboard. Yes you elicited the rule from them and there was a bit of confusion, but hey if you try doing this a little bit more in your lessons, the more you do it the better it will get.' And I think that I'm quite sold on [this]. There were things in that lesson that I thought 'wow, I haven't done it like this before. This is good.'"

At the end of the feedback session Matthew said:

"[The project] has triggered something. If it hadn't been for this project I wouldn't have done any of this. It's started something. What would be good would be to meet up again at some point, in a month's time or something and give you some feedback on how I managed to build on this."

Final Discussion Session: Implications for departmental practice

This meeting was held 11 days after the lessons had been taught. I asked what further thoughts they had had about their lessons and whether they had continued to use the ideas they had developed.

Callum said that his lesson had been a "reinforcement that computer-based training is not appropriate – it has to be teacher-led". The pupils enjoyed using the MyMaths resource and have asked every lesson since whether they will be using it, but Callum is using MyMaths as a whole-class resource rather than individually. Since the post-lesson discussion it appeared that Callum had reflected further on how to use the ICT effectively, because the method he now explained is different from the ideas he mentioned at the time.

"The pupils are all using the resource up on the IWB, it provokes discussion and allows pupils to access the ideas they will need to be able to answer questions and to complete a worksheet. "I don't want 'here's a text book – get on with it' I want them to talk about it, I want them to have at least one lesson in four when they aren't touching a pen".

In another situation the lesson had confirmed Callum's attitude towards ICT.

"I am a great believer in IT [lessons] of letting them play [with software] because actually that's how I think most of us actually do learn, but in maths I don't think it's that appropriate – it has to be more structured. It's the difficulty of getting the interactivity but the interactivity having meaning. Now I think on the original resource … I don't think there was enough interactivity. I went the other way; I did too much."

Matthew said that his main focus was wanting to have more interactivity and that he has done it again since. He plans to pass on his experience of discussion in the lesson to his colleagues on a cross-curricular literacy group. Matthew reiterated that he had used "the wrong part of MyMaths" with the pupils. Neither Callum nor Matthew were happy with the way they had used MyMaths the first time. Matthew suggested that they could share their experiences with the rest of the department as a way to ensure that colleagues don't make the same mistakes.

Callum has developed a new way of teaching where he has pupils sitting close to the interactive whiteboard and individuals go up to the board to help him lead parts of the lesson. This came as a response to the video clip in which he felt the pupils were not engaging enough with the ICT: "I found it frustrating that she wasn't using the technology to its potential." His first idea had been for the pupils to work individually at computers but he thought that this did not work either, so he instead used MyMaths with his low attaining Year 7 group in a whole-class interactive way. This worked so well that Callum has used the same idea with other classes since then, including a higher tier Year 11 group, and has been surprised at how well those lessons have gone.

Matthew wanted to "spend more time with the initial [T-MEDIA] resource." "The technology wasn't the thing that struck me, really, it was the style of teaching and the interactivity with the kids which I don't do a lot of … and it was a real eye-opener." "It did make me reflect on the way I deliver my lessons. I use the interactive whiteboard a lot, but I tend to use it pretty much as a projector. I prepare lots of overheads. At the ten-minute start of each new topic I explain things on the board, and I interact with the whiteboard and it was just that thing about getting the kids to contribute more and getting the kids to talk about things and the kids to come up and do things, and even if they make a mistake it's not a big problem; we can still use that and turn it to our advantage."

Matthew was very clear about the role that the video had played in the development of his teaching: "I've tried doing a few things even in the last couple of weeks that without this stimulus I wouldn't have changed, but I'm very conscious that it's going to take a little while for me to hone my skills because it's changing a style of delivery."

Matthew explained that at the end of Friday's lesson he used the game at the end of the MyMaths negative numbers work where two pupils are supposed to answer questions alternately and at speed, standing up at the board (and using it interactively). He had been frustrated because everyone else in the class had wanted to be involved and were shouting out answers. I suggested that this could be rather a good thing and that if the pupils were allowed to shout out answers the person at the board would still need to think about the questions to ensure they chose the correct answer from the different ones being called out.

Matthew was again explicit about how much he had got out of this experience. "Going back to what was valuable about resource … the conversation that you and I had after the lesson when we sat in the maths office was really valuable. I really focused on the couple of things that had gone a bit pear-shaped… When you reeled off all the positive things that you had picked out from that,

you know, just having that conversation and even in a lesson where you regret something didn't work, and for an objective observer to say 'I loved the way that happened' and "what about when so-and-so said" and "I loved it when so-and-so said that" and again, as a department these conversations never take place."

It was clear that the participants felt they had benefited from participating in this trial. There was recognition that discussion of this sort did not usually take place within the department and that it had been valuable. There was a desire to continue to do this, either by continuing the current group or by disseminating to the rest of the department.

Particular recommendations that arose for departments that might undertake this as a focus using materials from a website include:

- It should not be used in isolation by individual teachers but by a small group.
- A group size of 3 or 4 would be ideal.
- The discussion that took place was a valuable part of the process. Those who are involved should realise that this is not INSET that is done to teachers, but INSET that is done by teachers.
- The teachers should know that the videoed lessons are not being presented as being best practice, but that they just show one particular way of teaching a lesson.
- The project needs a co-ordinator to follow the guidance that is given. Ideally there would be session plans that the participants can follow.

Some final thoughts from the participants:

Matthew: "I am hoping that we will get a chance to meet again"

Callum: "It's done what it was designed to do, it's been the catalyst for the conversations that we've had, but my concern is if it was delivered just through the post, then would the head of department look at it without clear instructions and clear guidance? Possibly not. Probably not."

Precisely for this reason, we had been commissioned to produce the supporting 'toolkit' whose development is described in the next section.

Development of the "Research Into Practice" Toolkit

What follows is an account of the final phase of the project, looking at how the toolkit was developed and also how teachers used the toolkit independently of an external facilitator. At times the account focuses on one pair of teachers, Karen and John, to highlight some of the issues that can be brought out in the process. Note that the resulting toolkit document is appended to this report.

Creation and development of the toolkit

The toolkit was created using the model employed to pilot the CD-ROM resource (as described in previous sections), but with the aim of encouraging teachers to adapt the process to work independently within their own environments. The initial conception was to produce an introduction explaining each of the features of the resource and guidelines suggesting how a co-ordinator might run a training programme for colleagues. Team discussions led to the toolkit being expanded to include a resource screen list offering an overview of content and three alternative 'starter' routes through the CD-ROM, namely by: pedagogic theme, type of technology or lesson sequence. In selecting an example for each route we adopted pathways followed by teachers themselves in trialling the resource.

To increase accessibility, relevant screenshots were added as visual references within the toolkit text. Bearing in mind that some users may print out materials in black and white, the three routes were annotated with distinctively shaped symbols as well as colour codes (see Toolkit, Part 3). Alongside these materials, a flow diagram was developed to illustrate 'at-a-glance' the iterative process that the project is trying to encourage, and yet still convey the flexibility of the use of the resource. As a result of comments from teachers in the first two pilot schools, we further added comments on possible ways to integrate the process into schools, and a briefing sheet for Senior Management Teams which introduces the resource and toolkit and outlines what the proposed development activities will entail.

Trialling and Refinement of the Toolkit

by Anne Bowker, Research Associate

The toolkit trial

The toolkit was trialled with one mathematics department. Teachers used the toolkit to guide them through the use of the CD-ROM, with a researcher present to observe, but not interfere with, what they did. One teacher acted as coordinator and facilitator. During and at the end of the trial, teachers were invited to comment on the toolkit itself, and modifications were made in the light of their comments.

Background

The community college where the trial took place is an 11-16 comprehensive school, with approximately 430 students on roll, of which one fifth have special educational needs. The school is situated in a deprived urban area, and on entry, student attainment is below the national average. The size of the school means that funding is limited, and while three of the Maths classrooms have interactive whiteboards (IWBs), one does not, and there are no class sets of laptops or 'tablets' available for teachers to use. Three of the teachers have school laptops, but the most part-time of teachers has not. There are two computer rooms which maybe booked if not in use to teach ICT. One of these has machines set around the edge of the room, with chairs and tables in the centre (this is the room the Maths teachers prefer using); the other consists of three islands of computers, and thus has some pupils' screens hidden from the teacher's view at any time.

There are four members of the department, two being part-time. All are experienced and qualified maths teachers. They became involved in the project because the head of maths thought it would support their collective ICT development needs.

Karen (part-time)
Taught for 28 years
Taught here for 12 years

ICT use: uses games and other programmes, usually in class on the IWB; has been previously involved with piloting 'thinking Maths' in the late 90's.

Natasha (part-time)
Former head of Maths in Russia, where she taught for 15 years.
Taught Maths here for 6 months, and has been cover supervisor for 2 years

ICT use: relatively little experience (none in Russia) but keen. Also interested in expanding her knowledge of how English teachers teach.

John
Taught for 10 years
Taught here for 2 years
Co-ordinator for project

ICT use: mainly uses IWB as sophisticated whiteboard, with some use of programmes

Gil
Taught for 29 years
Head of department here for 10 years

ICT use: mainly uses IWB as sophisticated whiteboard

Timing

The department trialled the materials in a condensed 10-day period in the last week of February and the first week of March, owing to the NCETM project deadline. This was not an ideal time of the year, as they were heavily committed to mock examinations and preparation for key stage three and GCSE examinations in an already very short term (owing to an early Easter). Broadly they followed the pattern suggested in the flow diagram of the toolkit, but needed to break up some of the sessions, in part because their lesson periods were shorter. They 'made up' the shortfall of time by working at lunchtime and after school. The way they used the T-MEDIA resource is summarised in the diagram on the next page.

Using the T-MEDIA resource: what happened in practice

ICT Preparation: 50 minutes

Liaising with each other and technical staff re getting CD-ROM or web interface to work with the in-house technology & firewalls.

Session 1: 50 + 20 minutes

Co-ordinator volunteered; looked at each part of the 'introduction' on DVD (except tour of disk); and manually went through sample route;

Lunch time: Further familiarised themselves with toolkit and considered possible desirable outcomes/route.

Independent work

Looked at 'tour of disk'; some looked at all of the clips overnight.

Session 2 (part 1): 50 minutes

Discussed focus (year, pedagogical aim, programmes); Considered technological implications/booked rooms; looked at & discussed Clips 2.2 & 1.2; split into two groups.

Session 2 (part 2): 50 minutes

In pairs: Discussed possible games & maths content. Followed collaboration/motivation route; watched clips and looked at issues for discussion; considered game to use & discussed potential problems, strategies and advantages of using technology.

Independent preparation of lesson

Lesson: 50 minutes

In pairs: Teachers tended to begin lesson in class; students moved to ICT suite. Plenary sessions tended to include formal feedback from pupils about motivation/ collaboration.

Feedback: 30 minutes/lesson (+ 15 min as group)

In pairs: Discussed issues arising and reasons for actions, working through observations in chronological order; considered effectiveness of purpose (e.g. collaboration/motivation) & how to build on pupils' experiences in subsequent lessons.

In Group: Discussed future department needs & actions.

The story of the sessions

The first session did not go quite to plan. The day before the trial was due, the head of department was ill. She struggled in on the first day but without a voice, so it was decided to elect the other full-timer, John, to be co-ordinator. He had not had time previously to look at materials so the first session was exploratory for everyone. John commented later that ideally the co-ordinator should have looked through the materials and CD-ROM before the first session.

In addition, there were some technical problems on the first day: the ICT technician was initially unavailable, we were not sure whether or not Flashplayer 9.0 was installed (and the school's firewalls prevented us from downloading it), and we did not appear to be able to download material from the NCETM website. As a result, teachers crowded around my stand-alone laptop, with the CD-ROM running. As the days progressed, and with the help of the school's ICT staff, some of these problems were resolved: teachers used the CD-ROMs on their own laptops successfully, and became adept at trouble shooting it when it froze or 'flashed'. However, some operational difficulties seemed to be linked to processing capacity; it was apparently least problematic when used on more powerful home machines.

During the first session teachers followed the flow chart and looked at each part of the introduction on the CD-ROM, manually navigating through the screens. They did not, however, have time to look at the 'Tour of the Disc' (an audiovisual guide to the resource), which is last on the resource list under introductions. As a result of this observation, we modified the notes to the flow chart to suggest that the 'Tour of the Disc' feature was looked at first.

Overnight, teachers looked at the 'Tour of the Disc' and independently explored the CD-ROM. Some teachers had clearly looked in some detail at what the disk had to offer, and later the group commented that it was useful to have this time to explore the CD-ROM resource independently since what interested one person tended to be different to that of others. Karen explained why she felt this independent work was helpful:

> I didn't have a clear idea about where I was going to go with it, what I was going to do with it, until I had looked at it, and then thought about the things that we have got, and also I spent time looking at our IT and what I could adapt [….] You need more time around the edges; you can't just 'well, we have this meeting and then we will go off and do this, that or the other' [..] It doesn't necessarily mean familiarising with the whole group. I think that can be a pain, because you don't want to all look at the same thing: I wanted to look at all of the little comments [..] so when I was at home I could do all of that, and then look back at things.

During the first part of session 2, Karen pointed out that they would need to book the ICT rooms, and this prompted a discussion about with whom they would be working; it was decided to focus on Year 7, as all teachers taught this year group. They also noted that from the Autumn they would need to integrate ICT into the Mathematics curriculum for Year 7. After negotiating the (new) room booking system, all four teachers turned back to the T-MEDIA resource and looked together at Clips 2.2 and 1.2. These were chosen by common consent, but led by Karen and Natasha, who found them interesting in a number of ways. The group together critically appraised what they were seeing, were interested in ideas that they could use themselves and identified with the problems that Sarah (in the clip) had when the technology did not work as expected. The clips also prompted discussion about the need for teachers to be confident of the technology if they were to use it effectively in the classroom, and the problems they themselves were going to have with rather more limited technological resources: indeed, by the end of the first part of session 2 the Head of department commented:

> One consequence of this project is that I am going to put in a bid for 30 laptops. And not to share with anyone else either; just the Maths department!

They met again at lunch time to finish off the first part of session 2, and discussed using the thematic route, with a focus on motivation and collaboration, which they felt tended to be difficult for many students. Following this, John suggested that it would be helpful to have some suggested times added to the toolkit flow diagram, which were subsequently incorporated.

The time constraints were such that the group decided to work from then on in two pairs for the second part of session, the observation and the feedback sessions. Karen and John, teaching the two higher sets, worked together, as did Gil and Natasha who taught the two lower ones. The two pairs focussed on different aspects in the resource. Karen and John decided to look at improving student motivation and collaboration through using on-line games; whereas Natasha and Gil decided to look at on-line games to develop student understanding of Numeracy - the topic of Maths with which they felt their students had most problems – but with an interest in the impact that ICT might have on motivation. Natasha later explained:

> We chose to go through the technology route. For our [lower] ability [sets of students] it was useful. [I found on the web that] there is a huge range of interesting games for our level. The students, when they are 'playing', can do this work without [over-] thinking, because they automatically have got this knowledge. And it's like competitions: if they work in pairs, they want to be the winner; if they work against the computer they want to beat the computer as well. And it motivates, and pushes them to be perfect as well.

John and Karen used their session together to look at the appropriate clips, and go through the 'Issues for discussion', but also spent time discussing pre-planning issues of their proposed lessons, such as what program to use, how they had used it before, what had worked before, what mathematics the students might achieve, and how this would need to be scaffolded at various points in the lesson. John independently looked at the clips again later and used the T-MEDIA resource to record his reflections.

Technical problems once again intervened on the first of the two lessons: an upgrade over the weekend had left the machines in the ICT room temporarily unusable. Gil and Karen therefore began their lessons in their classes, using their IWBs to 'talk' pupils through the games they had chosen, with a fallback plan to abandon ICT on that day. Fortunately, 15 minutes after the start of the lesson, a message arrived to indicate that the computers were running once more, and so students were moved through the school to the ICT rooms. Even so, a further problem arose as the docking station for the staff laptops did not allow access to the programs required. Karen resorted to getting pupils to write their results on a common sheet of paper, because the technology she would use in the classroom to record the results would not work. These issues highlighted the importance of planning a non-technological 'fall back' activity when using technology, and this was fed back into the toolkit.

The second pair of lessons went more smoothly, from the point of view of technology. One teacher decided, anyway, to introduce the activity using the projection technology in his usual classroom before moving to ICT, whereas the other began in the ICT room. Much later, teachers commented about some of difficulties of moving pupils to and from a second room in lesson time; pupils get excited when moving to ICT rooms, yet their class teacher cannot be both locking up their own classrooms and simultaneously settling pupils into new rooms.

All of the teachers received positive feedback from the students. Everyone had used Micro-Smile, but whereas Gil and Natasha used it to give students opportunities to use simple number games, Karen and John used the 'bugs' program to encourage students to look for a pattern and a rule. The students in all the lessons were clearly enthusiastic, with almost all pupils riveted to their tasks. When Natasha said that they would be 'playing a game', and again, later, that it would be 'against the computer', there was spontaneous applause. At the end of the lessons, Karen and John explicitly asked students about whether they enjoyed the lesson, what they had learnt and whether they thought they had collaborated well, teasing out the reasons for why a few students did not think they had worked well together, and again almost every hand went up to say they enjoyed the lesson and worked well with each other. Pupils' comments included:

- 'it's exciting';
- 'it helps me concentrate better';
- 'the computer does the counting [recording] for you';
- 'you learn new things';
- 'you can do this at home too'; and
- 'I find it calm and peaceful, so I can focus'

The feedback/collegial discussion took place as quickly after the lesson as possible. Both of Karen and John's feedback sessions consisted of chronologically going through the most interesting events, with both teachers reflecting on what they had seen and what they intended at the time, as well as discussing what would need to occur in the follow up lesson (see diagram). The first feedback session, which followed Karen's lesson, also integrated decision-making, planning, discussion and advice for John's lesson (who had decided to follow a similar lesson plan). John was particularly interested in what collaboration using ICT might mean, and undertook an experiment in his lesson, deliberately getting some student pairs to take turns with the mouse while others had one person using the mouse and their partner instructing what to do. Karen, acting as a critical friend, encouraged and talked John around how this aspect could be set up so that the lesson would still run smoothly. The second feedback session included more discussion about what would need to happen in the next lesson, and reflection on how using ICT might prove useful in helping students with particular developmental needs.

Feedback

Karen's lesson: Topics of discussion

- **Motivation and collaboration and effect of ICT**
- **Setting up pairs in advance: not friendship groups, but alphabetical, adjusted around problems**
- **Demonstrating programme on the IWB in advance**
- **Opportunist use of this as a vehicle to improve skills (e.g. the importance of the correct use of B and b (big bug and little bug) which tends to be overlooked by this class**
- **Advantages of using ICT**
- **Handling the failings of technology**
- **Clarity of 'stop clicking' instruction to gain attention of pupils**
- **Difficulties of the room**
- **Nature of collaboration and sharing the mouse**
- **What to do next to help the pupils who struggled to collaborate**
- **What to do in the next lesson**
- **What John might do in his lesson**

Feedback

John's lesson: topics of discussion

- **Start of lesson**
- **Transition between rooms**
- **Engagement and speed with which they became on task**
- **Plenary**
- **What needs to go in next lesson**
- **Student attitudes to lesson**
- **Pupils who don't want to collaborate/ need to work on own**
- **ways of encouraging EAL pupil to communicate**
- **Alternative ways of explaining how to use software**
- **Reflection on the mathematical learning of the group**
- **Reflection on how ICT might help students with Asperger's Syndrome to collaborate**

What did these teachers gain from the experience?

Talking to teachers individually, and together, afterwards it became clear that what each had gained from the exercise was quite different. Karen, a key person in terms of what expertise she could give to others in the department, responded frankly: 'very little', yet it had allowed her to highlight issues such as technological incompatibility between rooms and the lack of time to get to know the full range of programs they already had. Discussing the opportunity to observe colleagues she highlighted the small and collegial nature of this department: they would go in and out of each other's classes to collect resources, so everyone had informal opportunities to observe each other, and share ideas.

Others were more obviously enthusiastic. For Natasha, the exercise had given purpose to her developing ICT skills, and brought to light that she had been overlooked for a laptop, and did not have an IWB in her classroom. This prompted Karen to say 'we ought to do more swapping over of classrooms'. Natasha observed the advantages of using ICT with her low ability pupils:

> Sometimes to show [and for pupils to understand a small concept] it will take one lesson; here, it was just a few minutes.

She found the CD-ROM clips particularly interesting because of the way it expanded her repertoire of teaching Maths within the English teaching system; coming from Russia, her repertoire tended to include using less ICT and more of pupils explaining their ideas about maths to the class:

> I wanted to improve my skills on the computer. I have taught for 15 years, but every day you can always learn more. It was quite interesting for me, how [Sarah, in the clips] controlled her class, and that she didn't push students if they did not know; all the students there feel free; they can say anything that they want. She just tried to correct them in ways which reassure. She did not say 'you are wrong' but 'did you mean '*that'*?' 'Did you say '*that'?*' I think it is another culture.

Whereas Natasha has had opportunities, in her other role, to observe colleagues for a length of time and across many subjects, John has had fewer such opportunities, much less to discuss a colleague's lesson in detail. In addition, this exercise allowed him to use a program new to him, and in a way different to his norm, by conducting a similar lesson to his colleague's. One outcome was that he observed how the 'bugs' program and rule finding activity might further other areas of Maths:

> One of the kids said 'that's just like algebra'. It might be a good introduction to algebra.

Furthermore, he used this opportunity to experiment with different ways of encouraging pupils to collaborate, asking pupils to work together differently. John also had an opportunity to lead the group, through his co-ordinator role. Discussing whether this was a good idea or not, the group thought this was not a problem, and, provided colleagues worked well together, they thought other departments might find it helpful for someone other than the head of department to take on this role.

For Gil, it has spurred her on to explore what software they already had, and to use it:

> It has forced me to look through all the stuff we already have. I hadn't been through all the Micro-Smile stuff – I haven't been through all of it now – but I know a lot more about it now and I can use it with a lot more kids now than I could before.

At the department level she is now considering what is needed to enhance technology, such as what hardware is needed on a day to day basis, how this can be financed, how the department can find time to get to know programs and where and how they might get training for the software they already have.

Feedback concerning the toolkit, and further modification

After the final session using the T-MEDIA resource, the group came together to give formal feedback on the toolkit as well as the project in general (reported above). The newly modified parts of the kit were given to members to discuss. The group particularly liked/found useful the flow diagram and screen dumps. The introduction was thought essential, and fulfilled its purpose. The screen list was considered to be of greatest use once teachers had become familiar with the materials. Describing what she would advise other departments who were about to embark on the process, Gil reflected:

> I think you [first] need to know something about what it is all about and what's there on offer, and about the themes and the technologies [as given in the introduction..] and that flow chart, and maybe look at one or two things [on the CD-ROM] and [then] understand what that bit is about.

The SMT sheet was also given to Gil, as a member of the Senior Leadership Team (SLT), and also to another member of the SLT who was not involved with the project, for comment. They thought this was helpful, but raised issues such as cost implications and a plea to highlight how important it is for ICT staff to be informed of ICT implications two weeks in advance, suggestions which have now been incorporated into the sheets.

Conclusions

- Our trials indicated that participants from the three schools found the 'toolkit' useful in shortcutting and guiding their use of the T-MEDIA resource as a tool for supporting professional development. **The resource acted as a powerful stimulus for reassessing pedagogical thinking and practice and the perceived effects were dramatic.**

- The model of CPD proposed here is rather different from the conventional one-day INSET intervention by an outside expert, and other variants on that theme. It is **teacher-led, collaborative, voluntary** and based on **supported professional dialogue** and **reflection on practice** that are **ongoing over time.** We were interested to note the remarkably similar recommendations emerging from keynote speeches and related discussion about trends in CPD at the recent NCETM national conference on *The Potential of ICT in Mathematics Teaching and Learning* (where we also presented our findings and distributed copies of the toolkit to an appreciative audience).

- Our model has a clear focus too on **developing subject pedagogy – related to classroom use of ICT, or not,** as desired; there is an enormous amount of flexibility here as the resource raises many diverse issues. The range of foci that teachers selected to explore during our three trials clearly demonstrate that these **issues reach far beyond the specific resource context of teaching about straight line graphs in Year 8**.

- The findings offer a model of how the T-MEDIA resource might be used with other mathematics departments and teachers at all levels of (teaching/ICT) experience – in groups or individually – as a versatile professional development resource. **Bringing together teachers with a range of levels of experience** in each trial was indeed considered most fruitful. While providing a department with common purpose, using the resource and the toolkit in this way potentially **serves a wide range of different needs** of teachers simultaneously. It can offer **new opportunities to lead, to carefully observe colleagues' practice and understand their reasoning, to take stock and to experiment with new pedagogical techniques, and to explore the potential of new technological tools and software**. Indeed for subsequent cycles, some departments may find it useful to adapt the process to include facilitated training of a particular software program as a part of session 2.

- Different departments and teachers will inevitably chart different paths through the process. Our trials showed that some teachers are keen to explore the T-MEDIA resource independently before discussing it with colleagues; some teachers work effectively in pairs as 'critical friends'; and so on.

- A group size of 3 was considered a minimum and 3-4 probably ideal. The **rich dialogue that the resource provoked** (rather than the attempt to emulate what was portrayed) were the main trigger for change in thinking and practice. This involved teachers **generating new ideas, bouncing them off each other and building cumulatively on each other's suggestions**. Likewise the post-lesson discussions with a colleague observer not only reviewed important issues arising but offered alternative ideas and viewpoints to be considered in the future.

- The **role of coordinator** (not necessarily the Head of Department) is key in sustaining discussions and managing the process. A **cascade model** could be employed in larger

departments, whereby participants could act as co-ordinators for new groups involving other colleagues.

- We noted that even already collegial departments benefit from having a catalyst of this kind and **time and space made available to reflect on practice;** teachers commented that department meetings are very often taken up with other pressing concerns such as implementation of new policy or curriculum initiatives rather than discussion of mathematical teaching and learning. It is a welcome luxury to be able to spend the time analysing classroom practice, developing fresh approaches and putting new knowledge into practice.

- The process likewise offers a rare opportunity for teachers who are not performance managers to **observe – and collaboratively deconstruct – a whole lesson given by a colleague**. Teachers can also benefit from planning lessons together, supporting each other in developing and trialling new ideas.

- Of critical importance for the success of such CPD is **management support** for the process, including **teacher release time**. This was funded by the project in our trials but clearly needs alternative support in normal circumstances. Some schools (including the one participating in our first trial) are already devolving their INSET budgets towards shorter, more frequent (eg "twilight") sessions exploring ongoing issues over time, and this is one strategy that could prove fruitful here. The SMT briefing sheet in the toolkit was developed in order to inform school leaders succinctly of both the benefits and costs of what is involved. Any **logistical and technical constraints** need to be carefully identified in advance and addressed in order for the process to run smoothly.

- Our model is one of truly **continuing professional development that introduces an external stimulus yet prioritises and values teachers' own aims, insights, experiences and motivation to improve pupil learning outcomes**. It is also based on the **critique of real examples of practice** in an ordinary class including low attaining and behaviourally challenging children.

- In sum, we have seen how with support at school level and from the toolkit, exploring a single but rich and flexible resource was highly appreciated by a very diverse group of teachers as a means of opening windows on practice and **moving both classroom and departmental practice forward in ways that they wanted to sustain over the long term.** We very much hope that other departments around the nation might benefit in similar ways through accessing the multimedia resource and the toolkit via the NCETM portal.