

Thinking Together around ICT in the Primary Mathematics Curriculum: Improving Classroom Practice

Final project report to the Nuffield Foundation

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Introduction

We begin with a brief review of the rationale and aims of the project, including a summary of the extent to which the aims have been met. This is followed by a detailed account of the phases of the project which notes any changes to the original proposal and presents the findings of formative evaluation at each phase. This is followed by a summary of the research findings and the outcomes of the evaluation of the continuing professional development materials (referred to as the CPD Pack) that have been produced by the project. We then describe the contents of the CPD pack. Finally, we describe how this pack is being disseminated and our plans for continuing this work.

Rationale

This project emerged from our *Language, Thinking and ICT in the Primary Curriculum* project (EDU/00169/G) and was designed with the explicit intention of implementing and disseminating the findings of the earlier project. The earlier project had demonstrated that the Thinking Together approach to using ICT activities improved KS2 children's ability to work together on mathematics and science activities. Measurable gains in children's learning and understanding were also found (as reported, with reference to science, in Mercer, Dawes, Wegerif & Sams, 2004). In that project, however, we were not able, except in a limited exploratory fashion, to incorporate principles of the Thinking Together into the commercial software used in activities. A logical next step was to embody features of the Thinking Together approach which had been found to help structure activities into a range of high quality software and text teaching materials and support the use of this software through specially-designed guidance for teachers. We therefore proposed a collaboration between the Open University team and the well-established curriculum and resource development and teacher training team, SMILE Mathematics. The MicroSMILE software development group there were already applying Thinking Together principles to their software design. However they recognised that if software is to be used effectively in the classroom it needed to be supported by an appropriate pedagogy, which in turn implies effective professional development. The Open University research team, in collaboration with SMILE, therefore sought funds from the Nuffield Foundation to develop and evaluate pedagogical strategies and lesson plans and so produce a CPD pack for the Thinking Together approach with ICT in the primary mathematics curriculum.

Aims and objectives

The overall aim was to improve the quality of teaching and learning through the use of ICT in mathematics at KS2. Our more specific objectives were:

- 1) To develop detailed guidelines and lesson plans and incorporate these into a professional development pack for use with SMILE software by KS2 teachers;

- 2) To evaluate the effectiveness of using the professional development pack in combination with the new collaborative range of SMILE software (as well as existing activities);
- 3) To disseminate the findings and the products of the project in such a way as to have the maximum possible impact on the way that ICT is used to help teach mathematics at KS2.

The first two objectives have been met in full. Information and resources are already available on the Nuffield Curriculum Centre web-site and a CPD Pack consisting of a book and CD-ROM is now being printed and will be launched in January 2005. A draft copy is attached to this report.

The third objective, dissemination, is ongoing. The research team have been disseminating the products and findings of this and the earlier project through a range of workshops, conferences and publications for teachers and academics (including some events in other European countries). The published CPD Pack will be available in time for a launch at BETT 2005, the British Educational Technology and Training show. SMILE are advertising this pack and using it in draft form for their own extensive INSET programme, which reaches many schools and LEAs. The Nuffield Curriculum Centre is contributing to the task of dissemination by displaying extracts from the pack on their web-site.

Phases of the project

The project had three phases described briefly below.

Phase 1. Developing resources (September to December 2003)

In the first phase we developed resources through a classroom-based investigation of the use of SMILE's new software as a support for collaborative learning. For this phase we worked with year five classes (9 and 10 year old children) in two primary schools where the Thinking Together approach was already used extensively. In each of these schools, a lead teacher who was experienced with the Thinking Together approach mentored another teacher with less experience.

Our involvement with these four teacher-researchers began with a professional development session in which they shared experience, enhanced their understanding of the Thinking Together approach became familiar with SMILE mathematics activities. This was an afternoon session combined with a follow-up after school session one month later. The teachers trialled a special shortened version of the Thinking Together programme which consisted of three, one-hour activities for promoting the skills needed to help children work and learn together effectively on ICT-based activities.

We observed and video-recorded twelve lessons in this phase. These lessons included three new lessons on Thinking Together around ICT in maths, which incorporated a generic maths activity using 'Magic Squares' software. Children were also observed working with other MicroSMILE activities from the software packs *Co-ordinates* and *Numeracy*: '3 in a line', 'Rhino' and the multiplication software 'Tenners'. We recorded interviews with three teachers and two groups of children about their experience of using the software and about the effectiveness of the approach. This feedback was very positive but also formative. Other school visits enabled us to gain more informal feedback from teachers. All the children involved, eighty-nine in total, were assessed at the end of the term, using questions based on the maths content of the software that they had used. The teachers who evaluated the results of this test were impressed by the number of children who provided clear written reasons for their

claims. As part of strand AT1 of the Maths curriculum children are expected to become able to give reasons for their answers to maths problems, but teachers have found the development of this ability difficult. Our approach of encouraging children to think together around mathematics software provided one solution to this problem.

Our observations and the feedback from the teachers indicated that the combination of SMILE mathematics and the Thinking Together approach was a powerful one. The SMILE mathematics software we used all involved games of strategy and we found that playing a strategy game against the computer in a small group proved a great stimulus for joint reasoning. The shortened version of the introductory programme, incorporating one ICT-based activity, proved effective. This was a valuable finding because previous research using the Thinking Together approach had led us to think that a longer period of introduction and practice (about ten weeks) was a necessary requirement.

During the first phase, we worked closely with the four teacher-researchers to develop a trial version of the CPD pack. We mapped out the necessary contents of a draft CPD pack and selected illustrative video-clips for the pack from the classroom recordings –including examples of teachers intervening in groups, introducing the ‘ground rules’ for group work and using whole-class plenary sessions to encourage children to review and reflect on their activities.

Phase 2 Evaluation and transfer. January to April 2004

We began the second phase, in early January 2004, by running a whole day CPD session using the draft CPD pack created in Phase 1. Six teachers previously unfamiliar with the Thinking Together approach were invited to take part in this session, two year five teachers from Milton Keynes and four year 6 teachers from inner London. However, two of the London teachers were unable to attend at the last minute due to a crisis in their school and so these teachers were visited later by a member of the project team who took them through the contents of the pack. All six new teachers were interviewed about the CPD shortly after the training day and again towards the end of the project.

In the two new Milton Keynes Schools everything proceeded as planned, but access to one of the two London schools proved difficult. In all schools but that one, each teacher was visited three times during the term. Each visit involved the following:

1. One whole ICT in mathematics lesson was video-recorded;
2. The teacher was interviewed briefly about the lesson just observed.

This data fed into the development of the final version of the CPD pack.

Phase 3 Dissemination (May 2004 and ongoing)

In this phase, which has not yet come to an end, we have finalised the CPD pack and will begin disseminating it. Although based on the use of SMILE software, the pack has been designed to address general issues in the collaborative learning of primary maths through ICT activities. During this phase we have converted some of the CPD materials into a form appropriate for presentation on the Nuffield Curriculum Centre web-site. Andrew Hunt, director of the web-site, enabled us to present these in downloadable form. Both the SMILE web-site and the Open University ‘Thinking Together’ web-site will link to this site. SMILE will publish a full CPD pack with book and CD-ROM shortly, with a launch planned at the international educational technology show, BETT, in Olympia, January 2005. Short articles about the project and the pack are being prepared for the educational press to coincide with this launch.

Summary of research findings

The project was primarily a development and evaluation project, but it has also provided additional evidence concerning the ways in which talk helps children to understand mathematical concepts. The analysis of recordings of children's talk while engaged in ICT-based strategy games has revealed evidence of the development of their mathematical reasoning and increasing use of mathematical language. Of particular interest is the way children negotiate their strategies when competing together against the computer. This issue is being pursued and will be the topic of future publications.

Evaluation

The structure and content of the final CPD reflects the presentations and resources provided for teachers at the beginning of phase 2 of the project. The six teachers we worked with in phase 2 were completely new to the Thinking Together approach yet according to their immediate feedback the presentations and materials we provided were clear and provided all that they needed for them to apply the approach in their classrooms. All six teachers found the presentations motivating, some found them inspiring. They liked the two part structure of the presentations with the first session providing rationale and research background to the approach and the second section providing a practical guide on how to apply it. Some of their feedback included helpful suggestions, for example the need for more videos of classroom interaction. The following comment by one of the inner London teachers, from an interview recorded later, is typical of the general response to the draft CPD materials:

I thought the inset sessions were very useful, the presentations were clear. The video sessions were useful – I think from a teacher's perspective, its difficult to foresee how the programme will pan out with the children it might have been good to have more video sessions showing the development of the programme with a group of children.

All formative suggestions, like this one for more video clips, were taken into account and in the course of phase 2 of the project we worked with teachers to record the extra video clips required and to make sure that the resources, such as the lesson templates, matched their needs.

Towards the end of the project, in June 2004, we recorded interviews with all of the phase 2 teachers. They were all positive about the impact of the Thinking Together approach. All of them were impressed at the quality of talk produced by their children. The use of the Thinking Together ground rules in the context of playing strategy games against the computer was judged to be effective in stimulating reasoning, but all teachers also expressed a desire to take the Thinking Together approach into other areas of the curriculum. The following response was given by one an inner London teacher asked to sum up his view of the project:

It was very positive. I really think it's a strong idea and the more cross curricular links you could perhaps plan in the future the better. It's motivating and genuinely useful. Not just in terms of subjects but I would have thought as a life skill.

The two inner London schools we worked with in phase two of the project had a very diverse population and one interesting aspect of the project, which is the subject of continuing research, was the impact of the Thinking Together approach on children with English as an additional language (EAL). One inner London teacher commented on this:

With the EAL children it just improved their capacity to communicate with a peer ... It improved their capacity to solve problems and also in terms of feeding back to me and speaking to me as a teacher. Often I noticed after the project that they were better able to concisely describe what

their thinking was, what the problem was that allowed me a greater insight into how to help them move on. So it wasn't just the peer communication it improved it was the communication between myself and the pupil. That is very important especially where children, in that context with EAL who perhaps aren't attaining the national standards of English. ... I did really notice that even the vocabulary they were using they were picking up from those sessions and coming in with "I agree with you but could you explain why" and these phrases started dropping in to their every day language in different contexts which was my indication that it been very successful.

Everyone involved with this project has been impressed with the improved quality of children's reasoning after only a brief involvement with the Thinking Together approach. The main reason for this appears to be children's use of Exploratory Talk (generated by the ground rules learned with their teacher) when playing strategy games in groups against the computer. The children we interviewed found this context highly motivating and they found that reasoning about strategies together really worked in that it helped them to beat the computer. The feedback from children, teacher-researchers and university-researchers working on this project tells us that the use of ICT activities in Mathematics is an effective context for introducing the Thinking Together approach into teaching and learning within the curriculum. The positive effect that has been reported on the way that children talk and think together was achieved using draft CPD materials which have now been converted, with improvements, into a high quality CPD pack to be launched by SMILE in January 2005. Although we are not yet in a position to evaluate the impact of this CPD pack, all the indications are that it has strong potential for improving the quality of teaching and learning with ICT in primary mathematics.

Conferences, seminars and in-service training events and other dissemination activities to date

1. Keynote presentation by Rupert Wegerif, 'The role of ICT as catalyst and support for dialogue' National Conference of the *National Association for Language Development in the Curriculum* (NALDIC), London, Summer 2004.
2. Invited presentation by Rupert Wegerif and Neil Mercer 'Why collaborate?' to the BECTA Expert Technology Seminar on *Collaborative Technologies*, London, June 7, 2003.
3. INSET workshop by Claire Sams for Milton Keynes LEA November 2004.
4. Presentation by Claire Sams to KS 1-3 teachers, Walton Schools partnership, Milton Keynes, 8th January 2004.
5. INSET sessions by Claire Sams for Abbeys Combined School and Russell First School, Milton Keynes, June 2003.
6. Discussions with BBC producers of *CBeebies* web-site by Claire Sams, 28th April 2004.
7. Presentation by Frank Monaghan to a meeting of the British Society for Research into Learning Mathematics (BSRLM), Leeds, June 2004
8. Presentation by Frank Monaghan to Primary PGCE students at St Martin's College, Lancaster, July 2004

Publications

1. Mercer, N., Dawes, R., Wegerif, R., & Sams, C. (2004) Reasoning as a scientist: ways of helping children to use language to learn science. *British Educational Research Journal*, 30, 3, 367-385.
2. Sams, C., Wegerif, R., Dawes, L. and Mercer, N., (in press for 2005) *Thinking Together with ICT and Primary Mathematics: A Continuing Professional Development Pack*. London: SMILE Mathematics.
3. Wegerif, R., Littleton, K. and Jones, D. (In press for 2005) Stand-alone computers supporting learning dialogues in primary classrooms. *International Journal of Education Research*.
4. Wegerif, R. (2004) The role of ICT as catalyst and support for dialogue. *NALDIC Quarterly*, Summer Issue, Vol 4.
5. Monaghan, F (2004) Thinking Together – using ICT to develop collaborative thinking and talk in mathematics, *Proceedings of the British Society for Research into Learning Mathematics*, Vol. 24, 2, 69-75

Websites

<http://www.nuffieldcurriculumcentre.org/go/screen/minisite/ThinkingTogether/Introduction>
<http://www.thinkingtogether.org.uk> [link from 'projects' on main menu]

Contents of the CPD pack

The pack consists of a 72 page book - ISBN 1-84554-257-6 – and a CD of resources. The title and contents are as follows:

Title: Thinking Together with ICT and Primary Mathematics: A Continuing Professional Development Pack

Contents:

Introduction

Module 1

Module 1 Section 1: A Bit of History

Module 1 Section 2: Types of Talk

Module 1 Section 3: From Thinking to Learning - ICT and Thinking Together in Maths

Module 2

Module 2 Section 1: Getting Started, Developing the Approach

Module 2 Section 2: Strategies for Teaching Thinking Together: Lessons using MicroSMILE software.

Module 2 Section 3: Planning Lessons and Evaluating Progress

Introduction to Thinking Together Lessons 1-3

Introduction to Thinking Together Lesson 1: Talking about Talk

Introduction to Thinking Together Lesson 2: Agreeing the Ground Rules

Introduction to Thinking Together Lesson 3: Magic Squares: Practising the Ground Rules p

Appendices

Appendix 1: Lesson Plan Template 1

Appendix 2: Lesson Plan Template 2

Appendix 3: MicroSMILE Software Framework – Framework References and National Curriculum links.

Appendix 4: National Curriculum References

Appendix 5: Talk Diary

Appendix 6: Introductory Lessons: Teachers' Notes and Resources

Contents of the CD

- 2 PowerPoint presentations supporting Modules 1 and 2 in the pack;
- 18 video clips showing classroom interaction and demonstrating the Thinking Together approach in action;
- over 20 printable resources for teachers and teacher trainers, including lesson plans, cue cards and assessment activities;
- free demonstration versions of two MicroSMILE activities used in the project.

The research and development team

1) From the Open University

Dr Rupert Wegerif – Project Director (Formerly at the Open University, now at University of Southampton)

Ms Claire Sams – Project Officer (Open University, now returned to teaching)

Dr Frank Monaghan – researcher with special responsibility for EAL issues

Dr Jenny Houssart – researcher with special responsibility for maths issues

Dr Karen Littleton – researcher with special responsibility for ICT and collaboration

Professor Neil Mercer – adviser on research methods and outputs

2) From SMILE

Nathalie Manners, Business Manager

Pat Cajee, former Business Manager

Michael Quigley, Software Development Manager