

## **Issues of collaboration and co-construction within an online discussion forum: information ecology for Continuing Professional Development**

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### **ABSTRACT**

This study was part of a collaborative e-learning project for continuing professional development (CPD) as part of which teachers participated in online discussions on an aspect of young children's mathematical development and related pedagogy. Analysis of the discussion data through tracking lexical links formed by 'cohesive ties' highlights rich language use and collaborative meaning-making. Analysis of transcripts of telephone interviews with teachers participating in the online discussion emphasises the extent of their meta-cognitive concerns and indicates deepening levels of learning. The findings indicate that the dialogical context can be enriched by teachers through the use of 'e-nat-graphics'<sup>1</sup> sourced from the children in participants' own classrooms. Woven through the study are questions concerning the impact of collaboration in the online project work in terms of its impact on the teachers' own practice, which also extended to some other colleagues. The findings suggest significant benefits for teachers who are involved in CPD through e-learning. As a consequence of their involvement, the Early Years teachers in the project incidentally reported increased confidence and enthusiasm about their own use of ICT.

### **INTRODUCTION AND BACKGROUND**

My interest in e-learning arose in response to personal experiences in providing 'traditional' (face-to-face) CPD for teachers over a number of years. I had questioned the extent to which face-to-face provision had any deep impact on teachers' thinking and practice. E-learning appeared to offer a new means of supporting teachers in CPD by offering greater opportunities for both learner-centred learning and continuous engagement with the programme. E-learning also offers increased opportunities for busy teachers to collaborate, through provision of online, asynchronous activities.

Further, recent research into early learning shows that "significant ICT training at a personal level is needed for many early years practitioners" (Moyle et al, 2002. p.136). The present study is located within the government's ICT agenda (DfES, 2003b; DfES, 2005) in trying to support teachers' confidence in ICT and e-learning.

The context for discussion focussed on an innovative and extensive, evidence-based research study we had conducted into children's mathematical graphics<sup>2</sup> (3 – 8 years; Worthington and Carruthers, 2003). Many of the project teachers explained their interest in the content of the online discussions as a specific reason for choosing to participate. It is also important to note that teachers recruited for this project were committed, enthusiastic

and generally highly motivated. Most also teach in 'Early Excellence Centres'. During the term-long project they were able to simultaneously develop their own practice and incidentally to acquire new skills and confidence in the use of ICT, which would allow e-learning to be embedded within their everyday teaching.

In the past online learning has often resulted in a re-creation of teachers' normal, pedagogical practices (Cooney and Stephenson, 2001; Alexander and Boud, 2001). My interest in e-learning arose in response to personal experiences in providing 'traditional' (face-to-face) CPD for teachers over a number of years. I had questioned the extent to which face-to-face provision had any deep impact on teachers' thinking and practice. Feist (2003) has similar concerns observing that CPD initiatives have been criticized "for their failure to produce significant changes in either teaching practice or student learning" (2003, p.1). E-learning appeared to offer a new means of supporting teachers in CPD. On the basis of this rationale, I undertook to investigate whether working online collaboratively with a colleague (from the same setting) supports both teachers' learning and to consider whether teachers shared their learning online with other colleagues who were not involved in the CPD project.

The specific aims of the project were as follows:

- to explore ways in which learners use context and language in constructing understanding;
- to assess the impact of involvement in online discussion in pairs, on teachers' pedagogy; and
- to evaluate the extent to which e-learning provides an effective means of professional development for teachers.

For the purposes of this study I use the term 'collaboration' to refer to teachers learning through shared discussion within the on-line community of practice and teachers collaborating in pairs. Some teachers joined the project with a colleague, allowing involvement of pairs to be evaluated.

This paper is based on a jointly managed project though the research presented here was carried out independently.

## **LITERATURE REVIEW**

The literature review briefly explores dialogue and meaning-making, collaboration and e-learning for CPD – all central themes of this paper.

### **Dialogue and meaning-making**

An important theme of this study is the way in which dialogue supports learning. One view is that the cognitive conflict of dialogue impacts on the learning processes. When presented with a representation of a concept, which differs from one's own, and the rationale for this view, the learner may reconsider and modify their own representation of the concept.

In this view, language originates "in social interactions and struggle" (Maybin, 2003, p.64). An alternative, although related view, is the collaborative nature of dialogue as learners work together to build new understandings. Meaning is "realised only in the process of active, responsive understanding" between speakers (Volosinov, 1929/86, pp.102-3). (See also Laurillard's (2002) conversational framework).

The listener's role is implicit and active, requiring 'thoughtful attention' (Fiumara, 1990). Mercer's (2000) introduction of the term 'interthinking' helps focus our attention on the collaborative, co-ordinated intellectual activity of language use, and its significance within the context of meaningful online dialogue.

Language use within online dialogue supports learning and helps the development of understanding through distributed cognition. Boland et al. (1994) define 'distributed cognition' as "the process whereby individuals who act autonomously within a decision domain make interpretations of their situation and exchange them with others with whom they have interdependencies so that each may act with an understanding of their own situation and that of others". They argue that "information technology can allow individuals to make rich representations of their understandings, reflect upon those representations, engage in dialogue about them with others and use them to inform action". According to Boland et al, distributed cognition is supported by an inquiry process that is "reflective in nature and which allows users to challenge their own assumptions". This perspective emphasises the links that exist between the focus on interaction, reflection, social processes and language and joint meaning-making as evolving (see Srinivasan, 2003).

In addition to the meaning and organisation of words within speech or writing, another way in which we communicate is through the use of grammatical and lexical links between phrases "so that the meaning of a long stretch of language is achieved by the relationship between these smaller units" (Mercer, 2003, p.60). This feature of 'connected speech' is cohesion. Cohesion refers to the use of language to bind what might otherwise be freestanding sentences or chunks of talk or writing into a unified text. Cohesion also marks continuity in the development of ideas. Cohesion is typically achieved by nominalization (using a noun to refer to a previous idea; see e.g. Vygotsky's ZPD), substitution (using a pronoun instead of a noun or using a synonym to refer to a previously mentioned idea), repetition, *exophoric* reference (reference to an agent or object outside the immediate text) or cross-referencing.

Analysis of the cohesive links across stretches of talk and across speakers, whether face-to-face or online, gives an indication of how the speakers develop and build upon each other's ideas. Mercer (2000) suggests that this form of transcript analysis is one way that can highlight participants' continuous lines of thought and amplify development of shared meanings. The 'cohesive ties' analysis used in this study was developed by Stokoe (1996, cited in Mercer, 2000).

A third way in which participants can share and construct meaning in online forums is through the use of visuals. The discussion in this study focussed on an innovative and extensive evidence-based research study conducted into 3 – 8 year old children's mathematical graphics (Worthington and Carruthers, 2003). Examples of the children's

graphics, which were sent in by the same teachers who were involved in the discussions, were displayed in the forum. This provided an additional visual context and resource informed by Mercer's argument that language is often used in conjunction with gesture and drawings "which can be used to draw physical artefacts into the realm of the conversation" (Mercer, 2000, p. 23). "The world told is a different world to the world shown" (Kress, 2003, p.1).

Further, the examples of young children's mathematical graphics also have a pre-history – of others' marks and written methods – and are, therefore, polyadic. Each representation encapsulates themes, styles and thoughts of others, whose earlier representations – like vocal utterances – themselves embrace features of others' representations. Wells (2000) argues that "because each advance in representing, the previous modes were not lost, we have a repertoire of modes to hand". 'Original' creative acts, whether speech or drawings must therefore always be regarded as integrating the creative acts of others.

### **Collaboration and CPD**

In respect of working in pairs, a recent review of 17 research studies into collaborative CPD (not online) found that it was linked to "a positive impact on teachers' classroom practice" (Rundell and Seddon, 2003. p. 3).

Candy proposes that "for successful partnerships, a longer-term relationship, in which trust and confidence can be built up, has real advantages" (Candy, 1997, p.15). The value of pair work is exemplified by Holmes who concluded that students performed "substantially better when they worked in pairs" (2003, p.256).

The online socialization that Salmon so clearly outlines (2002) is recognised as significant in creating a sense of 'community' in which learners move from 'peripheral participation' toward 'full participation in the socio-cultural practices of a community' (Lave and Wenger, 1991, p. 29).

Totten et al (1991) and Gokhale (1995) argue that participation within semi-autonomous learning communities helps learners to be responsible for their own learning. Through doing so they become critical thinkers, analysing, synthesising and evaluating concepts; a target far removed from the more traditional didactic approach to teaching and CPD.

### **E-learning for professional development**

But online communities of practice are more than dialogue between participants. The increasingly widespread use of ICT in education, and of e-learning communities for adult education and development itself, contributes to the rapidly changing landscape of language and literacy. Kress argues that technologies, in particular television and computer screens, have now overcome the dominance of the book (Kress, 2003, p. 9).

Participation in e-learning communities alters the ways in we communicate and introduces new practices. For example, in place of the term learning community Nardi and O'Day (1999) use the term 'information ecology'. An information ecology is a "system of people,

practices, values and technologies in a particular local environment" that 'co-evolve' (p.49). Social practices, Nardi and O'Day argue, help shape the technologies and ultimately advocate ways to use adapt them allowing use of technology to be reciprocal and interdependent. For Nardi and Day there is a powerful synergy between changing tools and practices (1999, p. 75). It might naturally be expected that the development or evolution of new practices and approaches will disseminate into everyday, off-line, contexts.

However, Laurillard (2002) argues that "educational technologies, especially new ones, demand effort and ingenuity in the development of materials, but rarely is this extended to the embedding of these materials in their education niche" (cited in Shephard, Riddy, Warren and Mathias, 2003, p. 246).

One of the aims of this study is to consider whether a learner-centred approach to CPD, will indeed lead to the embedding of new ideas in practice in the classroom.

## **CASE STUDY**

In this project, discussions took place through an online forum on the MirandaNet website<sup>3</sup>. An innovative feature of this web environment is that samples of children's original mathematical graphics and photographs can be made visible on the same screen as the discussion. These examples appear on the left of the screen on the same page as the forum, as a moving slideshow. Members of the online community are also able to click on any 'thumbnail' to enlarge it. The concept for this feature derives from the project team but was developed through the technical expertise of MirandaNet's web manager. Of major consequence is the fact that examples of children's work are from the teachers' own classes.

The project recruited a cohort of 18 teachers from 'Early Excellence Centres' throughout England:

- 83% taught in under-fives settings
- 11 % taught in mainstream settings (Reception and R/Y1)
- 6% taught in special education (Reception)

Of these, 8 joined in pairs and 10 as individuals.

### **Data collection**

I based my study on a model of 'grounded theory' (Glaser and Strauss, 1967) enabling me to think systematically, critically and intelligently (Pring, 1978, pp. 244-5). Responses from teachers and analysis of transcripts also allowed me to prepare an 'audit trail' that established a chain of evidence (Schwandt and Halpern, 1988).

Data was collected through:

1. analysis of transcripts of the discussions;
2. questionnaires (end-point); combined with
3. analysis of transcripts of telephone interviews.

The analysis of the transcripts of the online discussions was done through tracking the use of cohesive links between messages. This allowed tracking of the extent to which thinking was distributed and collaborative. A quantitative measure of the number of postings from each teacher was used as an indicator of levels of involvement.

Questionnaires to establish participants' views on the social dimension of the online forum, and the extent to which this was helpful to learning, were sent by email and surface mail. 55% were returned completed. Rather than rely on this sample alone, I used the questionnaire as a basis for structured telephone interviews (see Appendix 1). This allowed me to explore issues in depth and provided validity through obtaining responses from interviews with all the teachers involved in the project.

The telephone interviews lasted for approximately twenty minutes each. Using the questionnaire to structure the interviews, I made notes while talking on the phone in order to have as close as possible a record of each teacher's response in their own words. It was anticipated this would allow for greater objectivity and, in addition, would also allow me to analyse the language used.

Using a telephone headset enabled me to transcribe the phone interviews and I was able to record almost all of each individual's words. I was very aware that I needed to have as accurate as possible a record of what was said and for this reason aimed for a close transcription. To estimate accuracy, in the first 25% of telephone interviews I read back what I had written as the reply to each question and asked the individual teacher to confirm the record. On the few occasions when there was some ambiguity I repeated the question or asked for clarification. In this pilot I estimated that what I had written down was over 98% accurate. The responses were analysed for recurrent themes in language use and to investigate the teachers' experiences and perceptions of online collaboration in pairs.

### **Methodology: gathering a chain of evidence**

#### *Language for learning; language about learning*

I was interested in ways in which teachers collaborate through online discussions to create individual and shared meaning. In order to analyse transcripts I used the 'cohesive ties' technique (Stokoe, 1996) allowing focus on a range of language techniques (Mercer, 2000, p. 59) and highlighting collaborative discussion.

First, through intensive reading of the transcripts of the online discussions I identified the recurrent use of three types of cohesive tie in this set of data:

- *repetition* – of a word or phrase;
- *substitution* – when one word (or phrase) is substituted for another with a closely related meaning; and
- *exophoric reference* – use of e-nat-graphics allowed for what linguists term 'exophoric reference' or 'linguistic pointing'. Mercer argues that this is an example "of the way in which talk is related to the physical environment" (2000, p. 23). The

combination of talk and e-nat-graphics (visible examples of children's work on-line) creates powerful contexts for meaning-making through two semiotic systems.

Then, I analysed the language teachers used during telephone interviews, again through intensive reading of the transcripts. In response to the question 'Has the project influenced your teaching?' I noted that three key themes occurred repeatedly. These themes were identified on the basis of certain commonalities in the use of language (Appendix 2):

- *meta-cognitive* – relating to thinking and understanding;
- *affective* – relating to feelings or attitudes; and
- *practical pedagogical issues* – referring to changes in teachers' practice as a result of their new knowledge.

### ***Collaboration – pairs and individuals***

There were distinct differences between the number of postings made by individuals (average of 6.8 each) whilst teachers in pairs made only an average of 3.1. Through analysis of telephone interviews I was able to compare teachers' experiences and perceptions of being in a pair.

Participants in pairs were asked if the experience of being in a pair had been helpful. Individuals were asked if, with hindsight, they would have liked to participate in the project with a colleague, or would like to in the future (yes/no answers).

The reported experience of the teachers individually was compared to that of the teachers working in pairs.

### ***Impact on practice***

#### Impact on teachers' own practice

To explore the impact of the online discussions on teachers' practice and to determine whether there were differences for pairs and individuals, I compared the numbers of contributions made by pairs and individuals.

To assess the extent to which the teachers considered that talk contributed to their growing understanding, I counted the number of occurrences of words relating to talk in their answers (see Appendix 3). I then calculated their use of 'talk' words as a percentage of all comments and compared the rate of occurrence of these types of words for both groups.

Next, using responses to the question 'Has the project influenced your teaching in the longer term?' I rated responses 'high', 'medium' or 'low' (level) according to teachers' descriptions of changes in practice (see Appendix 3). I then compared each individual's rating to their number of contributions, allowing me to determine if there was a relationship between number of contributions and reported changes in practice.

### Sharing new knowledge – responses from telephone interviews:

I asked the following questions:

- Did you have an opportunity to discuss what you were doing with colleagues?
- Did your input in discussion with colleagues, have an impact on their practice?

The responses were analysed and collated to establish whether and in what types of setting the learning from the CPD programme was shared with colleagues.

## ANALYSIS

### Language

*'Cohesive ties' analysis – from the transcripts of the online discussions*

The thread entitled 'different styles of children's learning' featured twelve contributions including the summary (omitted for purposes of analysis). This discussion had a high proportion of descriptive language.

Use of substitution was especially evident as teachers described young children communicating and expressing their thinking through different media, for example:

*"sensory exploration"*

*"sensory experience"*

*"exploring"*

*"explorations with ... "*

*"visual and sensual"*

*Repetition* featured to a lesser extent.

*Exophoric reference* was used least in this discussion since the topic did not use a child's example (e-nat-graphics) as a contextual foundation for the discussion.

In contrast, a transcript of a second discussion thread, which featured a child's graphics visible on the screen (entitled 'Nikita'), included several *exophoric references*, including: "this", "top left" and "Nikita's picture". Other threads featuring children's graphics notably also included a higher incidence of *exophoric references*.

The third transcript I analysed concerned 'different styles of children's learning'. Discussion of boys' approaches (in thread 'A') had led to a new thread on 'gender issues' where the word 'boys' exceeded that of 'girls' in a ratio of 2:1.

*Analysis of language used – from transcripts of telephone interviews (see Appendix 2)*

Three themes were identified as occurring consistently across all the transcripts. These themes were identifiable by the topic focus and the language used. Full details are provided in Appendix 2. Some examples of this language use are:

Meta-cognitive language:

"heightened my awareness"

"thinking more"

"Cleared things in my mind"

Affective behaviour:

"I value what they children do more now"

"I feel very committed"

"I was excited"

Practical pedagogical issues:

"I keep lots of samples"

"I'm quite into compiling and emailing attachments now"

"I'm more prepared to take what I know into schools and pre-schools and demonstrate good practice"

The distribution of these key themes across the teachers' interview transcripts are shown in Figure 1 below.

Meta-cognitive:	53%
Affective:	28%
Practical pedagogical:	19%

**Figure 1:** Language category: percentage of total number of words used to describe changes in thinking, feelings and pedagogy (from contributions in online forum)

**Socialization – pairs and individuals** (from contributions in online forum):

*Experience / preference for being in a pair*

The question asked was:

"Was it helpful to you to be with a colleague from your setting, in the project?"

All teachers in pairs responded to this question in the affirmative. 90% of those working individually also responded in the affirmative. The one remaining teacher was unsure, although positive about her individual experience.

Comments from teachers in pairs included:

"Just being able to have someone to discuss things with – (someone) who understood – was good"

"It gave us a chance to evaluate – two heads looking at it together are better – together we had more ideas"

"We discussed what was online"

"Twice we went online together"

Comments from teachers working individually recognised similar benefits:

"I did try to 'buddy' with a colleague at work. I explained about it and we looked at some of the children's work."

"It would have been enormously helpful! We have a 'sister' centre nearby. The two teachers there *sparked ideas off each other*. I spoke to their Deputy Head and he was very enthusiastic about what they were doing!"

However, on a quantitative measure teachers in pairs made an average of 4.75 positive comments each in response to this question, compared to individuals who made an average of only 1.4 comments (anticipated benefits).

### Impact on practice

*Level of involvement – number of contributions (from contributions in online forum)*

The eighteen teachers made a total of 93 contributions, ranging between 1 (lowest) and 19 (highest). Of these, individuals made an average of 6.8 contributions whilst teachers in pairs made only 3.1.

*Teachers' own comments that I rated: 'high', 'medium' or 'low' impact on their teaching examples of comment ( teachers own words italicised)*

High - both the content of responses and (very enthusiastic) tone of voice:

- 'Yes! I'm a total convert – most definitely! (emphatic) 'I put out lots of plain paper whereas previously I had emphasized mostly practical maths. I also value what they do more! It's been a real eye-opener – I couldn't believe I hadn't seen this before and that it was possible to teach in this way!'
- 'Yes! As well as being Senior Teacher I am doing my MA dissertation on developing confidence and intervention strategies in maths. My colleagues were so delighted with what the children did! The language you gave us was very strong (e.g. 'put something down on paper and enabling questions / comments). This sort of language leads to incredibly rich depictions – it works beautifully!  
I had a broad idea for my dissertation before I joined the project – now much clearer. I want to focus. I gathered 8 staff and gave them questionnaires – looking at their experiences of maths. I'm working with 8 children and 8 members of staff – these, people are very familiar to the children. The opportunities for rich mathematical language use is huge!'

Medium – content of responses show positive gains

- It has raised my awareness. I am still developing my practice and I keep lots of samples. It has helped me support Reception class teachers. Until recently I had

been a reception teacher and it is now one of my roles to support them. I feel more confident in talking to them.

- 'It's made me more enthusiastic about the maths – heightened my awareness and my ability to exploit opportunities with the children.

Low – content of response shows almost no perceived gains

In cross-referencing to levels of active participation – without exception – teachers with the greatest number of contributions (10 - 19) were found to report high levels of success / impact on their teaching. Teachers who had made 2-6 contributions all achieved medium levels of success within their practice.

Two teachers who had barely participated (1 posting each) reported almost no impact on their practice:

- 'Janet is head of the Centre and she has limited teaching time with the children, I don't feel qualified to answer this. Maybe you could ask Janet'
- 'I haven't done much – I was really sorry that I couldn't get more involved but it was so hectic here!'

This demonstrates a correlation between active involvement in the online community and impact on teachers' understanding and pedagogy. In Wegerif's terms, those who did not contribute 'failed to cross a threshold into full participation in collaborative learning' (1998, p. 38).

*Level of impact – perceptions of the value of talking, from transcripts of telephone interviews*

The language used by teachers in pairs and individuals was similar (see Appendix 3).

For pairs, 61% of positive outcomes referred directly to talk and discussion: for example we 'talked about what was on-line and what we were doing'; 'discussed the children'; 'talked about the maths'; 'bounced ideas off each other'. This suggests also that teachers in pairs had greater opportunities for face-to-face discussion about issues concerning the content and pedagogy in their setting.

However, individual teachers appeared to regard talk with a colleague – the very opportunity they were missing – as even more significant, since 69% of their comments related to talk.

*Level of impact – from transcripts of telephone interviews*

"I recently gave an in-house INSET to the teaching staff at school. I decided to use Powerpoint. I began with a brief up-date on e-learning and related it to the recent consultation document produced by the government in July this year" (Sarah, Wigan).

In their questionnaires, teachers were asked to say what they had learnt through their involvement in the project, how this had influenced their own thinking and practice. Responses ranged from a high number (ten or more) of aspects featured to none. Further 50% of the teachers felt that their involvement in the project had had some impact on colleagues' practice (Figure 2). Between them the teachers listed 17 different indicators of change. Examples include:

"Some staff doing NVQ training – it helped their understanding"

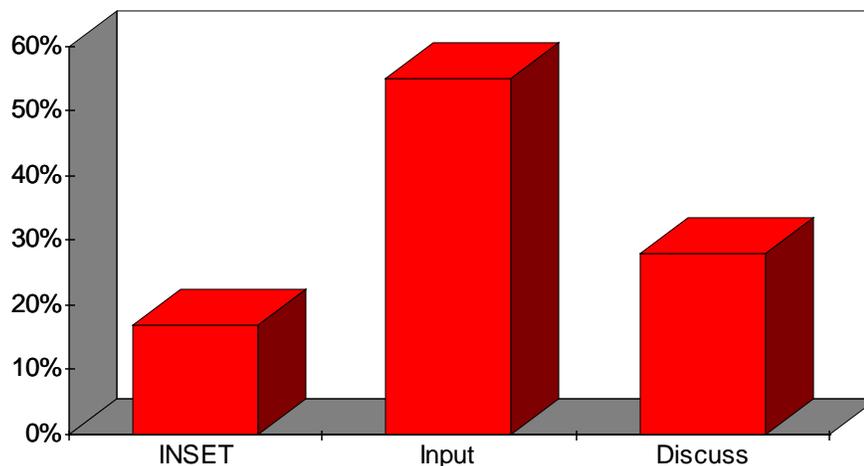
"SENCO interested"

"Staff in local day nursery more aware"

"Staff have been collating samples of children's work"

### SHARING NEW KNOWLEDGE Dissemination in setting

### SHARING NEW KNOWLEDGE Dissemination in setting



**Figure 2:** Sharing new knowledge: dissemination of new knowledge and practice

\* **INSET** – teachers led an entire INSET session

**Input** – refers to teachers' input to staff meeting  
**Discuss** - talked informally with some colleagues

## DISCUSSION

The findings from this study indicate some positive benefits for teachers in engaging in online discussions for CPD.

### **Aim 1: to explore ways in which learners use language and context in constructing understanding**

The 'cohesive ties' analysis showed that substitution allowed linkage of terms and topics between speakers: this helped them construct shared meaning. Individuals also used substitution several times within one posting, giving prominence to certain concepts and helping clarify their intended meaning.

*Repetition* had the effect of emphasising the topic(s) and may lead to clearer, shared understanding within the online community. Analysis of *repetition* demonstrated how a topic was carried over from one thread to another.

Since the content of the discussions all concerned the same subject focus, there was considerable *repetition* and *substitution* of language across threads. This linked internal topics in a complex web of understanding and indicates the extent to which teachers co-constructed meaning within the community.

*Exophoric references* were evident in those threads in which the central topic of discussion was one of the examples of children's graphics that teachers could see on the screen. Having the visual context available for reference clearly aided understanding and shows the value of having the additional visual context of children's graphics within the online discussion.

Analysis of contributions in the online forum revealed a high level of meta-cognitive language (53% of terms used) indicating that thinking (learning, knowing and understanding) was a significant feature of teachers' participation (see Appendix 2). Affective language (moods, feelings and attitudes) was also important, although to a lesser degree (28%). Only 19% of the language teachers used related to practical, pedagogical issues. Whilst practical issues are important for teachers' practice when developing understanding of a new aspect of teaching, this points to learning through CPD that goes beyond short-term or superficial 'ideas'.

Teachers' high level of emphasis on meta-cognition (whilst probably unconscious) indicates a concern with learning about learning. One of the features of this study was the powerful context provided by both text (talk) and the visual examples. Embedding teachers' examples of graphics may be one factor in contributing to successful outcomes and has the potential to be used in educational contexts across all subjects and all phases.

### **Aim 2: to assess the impact of involvement in online discussion in pairs, on teachers' pedagogy**

It is significant that no teachers listed negative aspects of being in a pair (either experienced or anticipated). The benefits (or for individuals – *anticipated* benefits) indicate high levels of satisfaction and expectation concerning the value of participating with a colleague. Teachers in pairs were clearly better placed to comment on a wider range of benefits than individuals.

It may be that since teachers from the same setting have a shared history, reciprocal knowledge provides additional support. Some comments raise the question whether there might be value in encouraging pairs of teachers to log on together, although comments from several of the teachers in pairs about the difficulties of meeting face-to-face may militate against this.

The level of affirmative replies from pairs reflects high levels of satisfaction with online collaboration. Individual teachers anticipated that there could be benefits to participating with a colleague, in future online discussions.

Collaboration led to positive outcomes in terms of developing shared meaning through language, and participation with a colleague (pair) provided many additional benefits. Through collaborative participation, teachers moved between discussions exploring (informal) theory building and pedagogy.

Differences between the number of contributions made by individuals and pairs (more than double those for pairs) may reflect the fact that teachers in pairs could also discuss issues with their project partner face-to-face.

### **Aim 3: to evaluate the extent to which e-learning provides an effective means of professional development for teachers**

Fullan argues that collaborative cultures are highly sophisticated and that “all successful change processes are carried out in collaboration” (Fullan, 1991, p. 349), although Dillenbourg argues that there is seldom agreement in what is meant by the word 'collaboration' (1999). In Salmon's model of teaching and learning online, interactions become increasingly collaborative as participants moved into Stage 4 – knowledge construction (Salmon, 2002. p. 11).

Teachers who had led INSET or contributed to a staff meeting also discussed aspects of the project with their immediate colleagues. Furthermore, some had discussions with other staff in their setting, with visitors (including student teachers and supply teachers) and staff in other Early Years settings. This is noteworthy since one of the key requirements of Early Excellence Centres is to disseminate good practice.

Lower numbers of postings appeared to relate to only average or lower levels of impact. The exception to this was a pair of teachers who had made 4 and 6 contributions each, yet whom I had rated with 'high' levels of success and impact on their teaching. This included some collaborative work that had a considerable impact on colleagues' and children's understanding and may have been due to their personal motivation.

Despite this exception to the overall findings, I noted a direct correlation between higher levels of contributions (suggesting higher levels of involvement) and the success and the impact on their teaching that teachers reported. Teachers acknowledged specific ways in which their involvement had impacted on their practice and these correlated with the pedagogical features we aimed to encourage.

I was able to evaluate the examples of their children's mathematical graphics that the project teachers contributed and which supported online discussions. A high proportion of these examples suggested that the children's thinking was supported by the teachers' developing understanding.

Almost all teachers discussed aspects of the project and their work with colleagues and 50% of teachers made some contribution to staff meetings. Over 15% led an entire session on mathematical graphics at staff meetings, something that we had not anticipated.

Teachers' reported changes in their pedagogy, examples of their children's mathematical graphics and instances of involving colleagues all point to the impact of their involvement during the course of the project. However, I am aware of the need for caution when drawing conclusions about impact since teachers' responses were subjective and I was unable to independently substantiate what they said.

Teachers' shared a stronger belief in self-efficacy and most reported a high level of commitment to change. Their enthusiasm for collaborative working and professional learning increased during the project. Furthermore, the recognition that peer support was beneficial featured strongly in many of the studies.

## CONCLUSION

Experiences of CPD through e-learning are blurring the divisions between tutors and participants: this suggests the potential for distributed cognition (Brown, Collins and Duguid, 1988; Lave and Wenger, 1991; Boland and Tenkasi, 1995).

In this study teachers' subject and pedagogical understanding developed significantly through online discussions, with an element of enjoyment and challenge:

“When you've been teaching for some years, most courses offer nothing new - they say the same thing, or they say the same thing in a different way. It's a very long time for me since something like this has come along. The difference with this (research) project is that it was an intellectual challenge” (Jan, Camden).

Involvement led to impact on teachers' pedagogy that occurred earlier than expected and extended beyond what we had hoped, involving other (non-project) colleagues and staff in and beyond their settings and is evident in examples of children's work. Comments during early weeks of the project indicated that teachers were able to relate what they were learning online and gradually explore their pedagogy. The experiences of pairs appeared to be particularly valuable; and this is an aspect that could merit further research.

For the participants in this virtual community of practice, this study has demonstrated that there are often unexpected gains and deep levels of learning, which in turn are carried forward to the children in the teachers' own settings. The extent to which CPD through e-learning appears to have impacted on teachers' practice, points to positive outcomes for teachers' professional development. It is hoped that this study will make a small

contribution to the rapidly growing body of evidence-based research on e-learning and education.

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## Appendix 1: Questionnaire

*This questionnaire was used as a basis for telephone interviews at end of the project*

1a. In the light of your experiences in the project this summer, was it helpful to you to participate with a colleague? Question asked to those in pairs.

For those who joined the project single, they were asked:

1b. In the light of your experiences in the project this summer, do you think it would have been helpful to you, to have participated with a colleague?

1c. What do you think the benefits for you might have been?

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2a. Were there specific benefits for you, of participating in the project with a colleague?

2b. Were there specific difficulties for you, of participating in the project with a colleague?

*Questions 2a and 2b only for those in pairs.*

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3. Do you have a computer and internet access at home?

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4. Would it have been helpful for the project teachers to meet f2f at the end of the project?

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5a. Did you have an opportunity to discuss what you were doing with other staff / colleagues?

5b. Do you think that what you were doing influenced their practice?

5c. Did you have a chance to discuss / explain the project with the whole staff?

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6. Has the project influenced your teaching for the longer term? Do you think you will continue to explore children's mathematical graphics with the children in your setting?

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7. Do you think you might be interested in developing your understanding and practice of children's mathematical graphics further?

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## Appendix 2: Analysis of language used

This table shows the most common words and phrases identified as indicators of metacognitive, affective and pedagogic impact (from telephone interviews based on questionnaires):

<b>Metacognitive:</b>	<b>Affective:</b>	<b>Practical pedagogical:</b>
Aware	More enthusiastic	Put out lots of plain paper
Believe	Value what they do	Keep lots of samples
Eye-opener	Feel more committed	Maintain graphics table
Raised / heightened my awareness	Really excited	Compile and send emails/attachments
Reinforced my thinking	Really interesting	Use the computer more with children
Made me think	I've enjoyed it	Did a lovely display
Helped me think about...	Much more confident	Made a difference with what I do with the maths
More open to...	Feel it works beautifully –	
Cleared some things in my mind	Surprised by ...	
Look with a critical eye	Been nice	
Know	Real learning experience	
More focus	Amazed by ...	
Thinking more		
Understand how...		
Consider		

Lists of words and phrases in each category are a representative example rather than a complete list. Some words and phrases were used by more than one teacher or in similar ways.

### **Appendix 3: List of words teachers used in their telephone interviews, relating to 'talk'**

*Examples of teachers' own words (from telephone interviews), where they used a range of terms referring to 'talk' (some phrases used by more than one teacher)*

'We could *discuss*...'

'We *shared ideas*'

'Talking - *getting and sharing information*...'

'Just *being able to discuss* – who understood, was good'

'We *talked about* what was online, and what we were doing and what the children did'

'We *bounced ideas off each other* – *talked about* doing things'

'It has been really helpful *to talk*'

'I *explained* about it'

### **Impact on practice: examples of teachers' responses**

'We are developing the graphics table and continuing to encourage that'

'We are more open to looking at mark-making for maths'

'I am now much more able to recognise early marks that are mathematical'

'I am looking at ways of supporting my colleagues as they support the children'

'I am working with each practitioner and want them to (each) follow one child's development over a year'

'I now keep lots of samples – this gives me evidence (of their development)'

'I put out lots of blank paper – previously I had emphasised mostly practical maths'

'I value their early marks more'

'I make observations and use them for planning'

'The project provoked me to analyse my own practice and I will continue to do this'

'I am making much more use of appropriate questions in child-initiated play and listening to the children's responses to their own marks'

'I am much more aware of the range of marks and feel more confident when making interpretations'

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<sup>1</sup> In the context of this study the term is used to refer to original examples of children's work or photographs of children working on their graphics. The term '*e-nat-graphics*' was chosen to reflect the way in which 'natural' or original visual examples from children were used in conjunction with the discussion forum. The use of the term is in contrast to e-graphics on the internet as 'electronic-graphics' that are (generally) professionally generated by an artist or e-graphics-designer.

<sup>2</sup> *Mathematical graphics* are young children's early mathematical marks that they use to represent personal, mathematical meaning. Development begins with their earliest explorations with marks through early written numerals and representations of quantities, to children's explorations with symbols and their own written methods of calculations (Worthington and Carruthers, 2003; Carruthers and Worthington, 2005).

<sup>3</sup> Available at <http://www.mirandanetac.uk>