Technology, Pedagogy and Education
Vol. 19, No. 3, October 2010, 327–343

Routledge
Taylor & Francis Group

Collaborative digital learning in schools: teacher perceptions of purpose and effectiveness

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Research on the place of digital collaborative learning in schools has established its extensive use for the provision of online courses (Stevens, 2007), for learning within schools (Orech, 2009) and as a means of promoting inter-cultural education (Austin, 2006). Given that teachers' understanding and practice in collaborative learning is critical, the authors examine in this article teachers' perception of collaboration and collaborative learning in terms of a model for understanding different levels of engagement with digital collaboration. They also seek to explore the reasons for teachers' perceptions and how this may impact on their participation in online collaborative learning projects.

Keywords: collaborative digital learning; schools

Both academic and government reports on the potential of information and communications technology (ICT) to transform learning in schools indicate that there is a growing interest in the ways that schools might collaborate, either locally or globally (Cress & Kimmerle, 2008; Ligorio & Van der Meijden, 2008; Office for Standards in Education, 2009; Salmons & Wilson, 2008; Welsh Assembly Government, 2008). These studies make it clear that teachers have a central role to play in this process but our knowledge of what teachers understand about collaboration has not been well developed. In this article we use the term 'collaborative learning' to mean a method of teaching and learning in which students are grouped together to explore a significant question or create a meaningful project. We have used the term 'collaborative' rather than 'cooperative' to indicate that the work is structured and goes beyond the exchange of foundational knowledge (McWhaw, Schnackenberg, & Abrami, 2003).

The empirical data which informs the research in this article comes from a well-established and on-going cross-border educational initiative called the Dissolving Boundaries (DB) programme. Detailed information about the programme is available on the programme website at http://www.dissolvingboundaries.org. Set up in 1999 to link schools in Northern Ireland with those in the Republic of Ireland, DB has three main aims:

- cultural – the development of cross-border links that promote cultural awareness;
- educational – promoting valuable collaborative learning experiences for pupils;
- technological – integrating ICT into the curriculum in a meaningful way.

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ISSN 1475-939X print/ISSN 1747-5139 online

DOI: 10.1080/1475939X.2010.513765
http://www.informaworld.com

A total of 320 schools, from the primary, secondary and Special school sectors, participated between 1999 and 2008. The Special schools are those which cater for students with moderate or severe learning difficulties who cannot be accommodated within 'mainstream' education. The data for the research reported on here was collected from 2006–08 when 150 schools were actively participating, with pupils between 9 and 17 years of age.

The programme uses both Moodle software (http://moodle.org) for text-based interaction between schools and video-conferencing for real-time interaction. Two applications of Moodle are extensively used: there is a *forum*, in which students can socialise and comment on work in progress and a *wiki*, which allows students to collaborate in a shared website on the topic they are studying. Schools are also given a small grant to facilitate face-to-face meetings between students.

Review of literature

International research identifies both the many benefits for learners engaged in collaborative learning and some of its limitations; benefits include deeper understanding of knowledge and of others (Bonk & King, 1998; Kasper, 2000; Muirhead, 1999; Salmons & Wilson, 2008). A collaborative approach places much of the responsibility for learning on the pupil; knowledge is socially constructed and is facilitated by peer interaction, authentic assessment and cooperation.

Problem-solving skills become important as the pupils address questions that are raised as a result of considering the views of their peers. The engagement in 'discovery-learning', in 'exploring new horizons' (Damon, 1984), in 'decision making' (Johnson & Johnson, 1998), in 'sharing different perspectives' with peers (Meloth & Deering, 1992), in reaching a 'deep level of understanding' (Meloth & Deering, 1992), in 'actively' participating in learning are all frequently referenced as educational advantages of collaborative learning.

Higher order thinking skills, such as analysis, synthesis, and evaluation, are frequently required and group analysis and sharing of perspectives become necessary (Bruner, 1984). Further outcomes of collaborative learning that are often mentioned in the literature are deeper level learning, critical thinking, shared understanding, and long-term retention of the learned material (e.g. Garrison, Anderson, & Archer, 2001; Johnson & Johnson, 1999).

However, many researchers identify circumstances where successful collaboration in an online environment may be restricted. Hmelo, Gotterer, and Bransford (1997) and Wegerif (1998) attribute the pupils' low achievements in their study to three parameters: access problems, hardware platform incompatibilities, and failure to integrate sufficiently the technology used for collaboration into the project. Nalley (1995) argues that a fundamental parameter for successful online group work is the level at which teachers will convince their pupils of the value of collaboration, to prevent them from perceiving collaborative systems simply as 'technological game playing' (Nalley, 1995, p. 14).

Our analysis of the existing research literature suggested that there were four key ideas that were particularly relevant for our study: the first was that social interaction was the single most important element in fostering collaboration (Gilbert & Moore, 1998; Wagner, 1994). In the research we carried out we wanted to test if this was true for teachers and pupils in the Dissolving Boundaries programme and in particular to see how the Moodle software we were using was shaping this social interaction.

Second, as noted above, some researchers such as Hmelo et al. (1997) and Wegerif (1998) attributed low levels of interaction in their study to three predominantly technical issues. We wanted to examine whether similar evidence was present in our work or if there were other reasons to explain limited collaboration between some of the schools.

Third, research suggested that 'success' in a school context was more likely to occur when 'meaningful pedagogical models were implemented' (Ligorio & Veermans, 2005, p. 271). According to these authors, this finding meant that when teachers had a clear view of what constructivism meant, they were likely to have a shared vision about inter-school project practice and goals. Later research also suggested that 'structural conditions at the level of the school organisation were more important than teachers' attitudes or expertise' (Ligorio & Van Keen, 2006, pp. 124–125). We wished to examine these propositions more closely in the work we were doing.

Fourth, previous work by Brush (1998), Johnson & Johnson (1993) and Soller, Lesgold, Linton, and Goodman (1999) indicated that placing pupils in groups was not enough for collaboration to occur. The stimulus for collaboration has to be planned and structured within the group; interaction does not just happen (Northrup, 2001); it has to be intentionally designed. We wanted to explore teachers' views on this issue.

The literature has less to say about teachers' perspectives of collaboration other than that the teacher's role changes from one of acting as a sole disseminator of information to one that focuses more on facilitation of pupil learning (Nunan, 1999). Little is available on teachers' conceptions of the nature, purpose and levels of interaction that occur in collaborative learning environments, particularly among younger learners.

We wanted to get a sharper understanding of what teachers understood this process to involve both in terms of interaction with each other and in terms of their management of collaborative learning with their pupils.

Research questions

In the current research we focus on three questions. First, what did teachers themselves have to say about what collaborative learning meant arising from their experience in the Dissolving Boundaries programme? Second, how successful was collaboration between partnered schools in DB, and third, what conditions made for the sustained success or otherwise of these partnerships?

Research design

The research design involved both quantitative and qualitative methods. An online questionnaire was administered to teachers through the Dissolving Boundaries website, using Moodle. All the teachers involved with the DB programme in 2006–07 were invited to respond. The response rate was 42% (71 in total); of these 64% were from primary schools, 22% from secondary schools and 14% from Special schools.

Data was also collected through focus group interviews. These interviews were carried out during the Dissolving Boundaries end-of-year evaluation conference. This residential evaluation conference is an annual event in the DB calendar and gives teachers the opportunity to meet face to face with their partner teachers and other colleagues, and to display collaborative work done by pupils. The focus group interviews were

audio-recorded and transcribed. Each group consisted of between six and eight members, and was facilitated by one teacher who was appointed from within the group. Some focus group interviews consisted of primary teachers only. Other focus groups included a combination of secondary and Special school teachers. The data was analysed thematically following a qualitative approach (Vaughan, Schumm, & Sinagub, 1996), searching specifically for the following information:

- key themes or common threads found by reading and re-reading the responses from the open-ended questions within the questionnaire;
- any commonality in phrases or sentences that may be used by respondents.

Further data was gathered by recorded interviews with four individual teachers, from two partnerships, one in the primary sector and one in the secondary sector. This data was also analysed thematically using the same technique.

Additional data was gathered from within the online Moodle courses (each course represents a one-to-one school partnership). The number of messages posted in each course was counted. Forums and wikis were also examined for content.

Teachers were asked a series of questions about what they understood collaborative learning to mean, what they saw as its benefits and its drawbacks and to reflect on examples in their own work. In the following section, we report on our findings, relating them to each of the three research questions in turn: teacher perceptions of collaborative learning, how successful partnerships were, and what factors enabled some schools to engage in advanced levels of collaborative learning.

Findings and discussion

Teacher perceptions of collaborative learning

The process of critical reflection by teachers on what they had achieved revealed a number of important findings. The first was related to the *purpose of collaborative learning*. For over half the teachers, it was concerned with 'building up a friendship', or as a teacher in a Special school put it, 'our focus would really be just improving social skills … recognising that they [the pupils] can make friends'. But other teachers working in secondary schools, while supportive of the place of learning about relationships, welcomed the focus on the subject knowledge. One typical comment from a teacher was that her pupils 'were actually learning rather than going through a continuous getting to know you exercise … it's joint work, friendships develop naturally through that'. Another commented that 'they learn the topic and they are learning respect and having to listen to one another'. We think these comments are extremely important. The way that teachers define the core purpose of such work will influence how they measure success: will they evaluate their work in terms of the pupils' improved understanding of curricular matter or will they be more interested in a different kind of knowledge, the knowledge of 'others' and indeed of 'self'? We return to this central point in the following section when we discuss what we mean by 'success' in collaborative learning.

Second, teachers displayed a growing awareness of the *nature of collaborative learning*, including its complexity. While Dissolving Boundaries was set up to foster cross-border links, many teachers found that 'collaboration' had to start in their own school. It involved 'teacher and student working much more closely as a team', it

meant pupils collaborating in groups and in the case of post-primary schools, it required collaboration between teachers including cross-curricular collaboration. In other words, the first stage in collaborative learning had to be constructed in the teacher's own classroom. This could involve pupils 'teaching' each other ICT skills, it could involve a small group building ideas for a story, helping each other draft a written outline and, in a few cases, it also included what one teacher called 'a kind of in-built evaluation and assessment of each other's work, they were learning from it and sort of influencing how they proceed'. When this happened it gave the pupils 'a sense of ownership of their work'.

The evidence from the interview transcripts suggests that when teachers evaluated the year's work with their pupils as part of their preparation for the review conference, this process led to 'deep' learning or 'learning about learning'. In a minority of cases teachers commented that when this happened they were surprised at 'how many of them said I think I am much more open to other ideas, cultures and people'. What these examples tell us is that teachers recognise that collaborative learning in their own classrooms can have rich layers, and that the attainment of higher levels can be stimulated by evaluation that probes pupils' reflection on the kind of learning they have taken part in.

The third key point to emerge was that collaborative learning had *different levels of interaction*; one comment, echoed by many others, was:

> I think I missed the point that it was supposed to be collaborative in that we did our area and we gave them information and they gave us their information so it wasn't really collaborative.

Another teacher recognised the limitations of simply exchanging information, 'rather than engaging the pupils from the other school'. A further comment made a neat distinction with the teacher noting that their work 'was mostly communication rather than collaboration'.

Where there were frequent exchanges between the two schools, it gave the teachers the experience of seeing that collaborative learning could be about sharing ideas and constructing new ones; one teacher in a very successful partnership put it like this:

> it's a process whereby equal partners work together at learning and sort of enable one another's learning by sharing ideas and … use the initial ideas to create more ideas. I think within that communication and cooperation would be two vital elements.

Another said 'our children would do some work on the wiki and then our sister school would say something and so on … we were working together, adding, changing and discussing the content of the wikis'. These examples provide evidence of 'knowledge construction' and we return to this issue in the final part of the article which explores why some partnerships seemed to work better than others.

The fourth finding from the interview data was teacher perceptions about the balance of *competition and cooperation in collaborative learning*. In one very successful partnership, a teacher was reflecting on what had happened when a group with different levels of ICT skills began using Moodle: 'when they're in a group, they're helping each other, they seemed to be enjoying it as well when they were showing each other how to do different things'. She observed that this cooperation also had a competitive edge to it when the pupils were working in a team that had pupils from another school: 'we found that it was bringing people in the group closer

together because they were trying to beat the ones in the other group … so it was more of a healthy and positive competition'. In other words, the competition was not between the two schools but between teams made up of pupils from both schools, competing to do the best collaborative work.

One particularly challenging aspect of this style of work was how to offer constructive criticism to pupils in another school, for example in terms of the characterisation of a story or the appearance of a jointly constructed wiki.

One of the teachers described how tentative his pupils were at first in offering comments:

> I remember the first few weeks they asked … can we tell them like maybe this is a different way or this is a better way … towards the end they knew how to … they were more friends and they were chatting, but they were still having a healthy criticism of each other's work. But they were learning from each other.

And as this teacher's colleague said about the long-term value of this:

> I think that's what they probably learn most out of it which will stick by them more than something academic. It was more just how they could criticise or say something … but still not wanting to hurt people's feelings.

This very powerful comment takes us back to that most fundamental of questions: what kinds of knowledge should we value? We want to suggest that these teachers' experience of collaborative learning has been an impressive journey in professional development that has led some of them to examine the core purposes of schooling.

How successful were partnerships between schools?

In addressing this question, we have drawn on three main sources of data: we used the interview data, evidence from teachers' response to an online questionnaire and schools' actual input both to the forums in Moodle and in the construction of wikis, to get an overall picture.

In the 2006–07 questionnaire, 79% of teachers rated their project as a 'success'; 61% of teachers said that all 'project outcomes' had been achieved, a response which was explained by a number of them saying that they had been overly ambitious in what they had planned to do. Later questions showed that 95% believed the programme had improved their pupils' ICT skills and overall motivation, 82% agreed that it had improved their communication skills, 66% reported 'improved self-esteem' and 60% 'better north–south communication'. For 95% of the teachers, Dissolving Boundaries had been a vehicle for their own professional development and, reflecting their rising aspirations, 43% said they would change some aspect of their work in the following academic year.

Exchange of messages in the Moodle forum

When teachers received training in Moodle, it was recommended that they would start with forum work, where pupils would exchange messages and get to know each other. Forums could be used for discussion of work-related topics as well as for social interaction. Wikis (web pages) in Moodle would be used later to present work done on chosen topics.

Based on the findings of past research, the Dissolving Boundaries team recommended group interaction in forums rather than one-to-one pupil messages. All Moodle courses were therefore set up in advance in group format. Each school partnership was allocated six groups, A to F. Each group would consist of approximately 10 pupils, five from each school. Some schools personalised their Moodle course. Instead of using Group A and so on, one partnership chose the names of wild flowers. Another partnership allowed the pupils to choose group names and they used 'Cool Kids', 'The Geniuses', 'The Cool Club' and so on. Another partnership used colours. Most schools retained the A to F setup.

Table 1 shows the total amount of interaction in terms of online messaging in Moodle forums between teachers and between pupils for 2006–07. Usage was divided into low, medium, high, very high.

The relatively low levels of usage may reflect the fact that, during the academic year 2006–07, Moodle was introduced for the first time to all teachers. Furthermore, the partnerships include 18 Special schools whose teachers, while making limited use of these communication tools, would have relied far more on video-conferencing for collaborative learning than 'mainstream' schools. Low forum usage can also be explained by the fact that some partnerships experienced difficulties with computer network constraints. Many schools, particularly primary schools, still have limited access to computers.

This data was used by the programme team at a planning conference in September 2007 to highlight the importance of frequent communication. As the data in Table 2 below shows, this led to a marked improvement in the volume of messages exchanged in 2007–08.

In 2007–08, the 'high' or 'very high' usage increased from 22% in 2006–07 to 35% in 2007–08. We examine the characteristics of the 'high' and 'very high' usage schools in the final part of this paper. At this point we can conclude that Moodle was fit for purpose for primary and post-primary schools; in other words, the technology

Table 1. Total amount of interaction in terms of online messaging in Moodle forums between teachers and between pupils for 2006–07.

75 partnerships in total in 2006–07				
	Low usage of forums	**Medium usage**	**High usage**	**Very high usage**
No. of messages	0 – 100	100 – 300	300 – 500	Over 500
No. of partnerships	33	26	9	7

Table 2. Total amount of interaction in terms of online messaging in Moodle forums between teachers and between pupils for 2007–08.

74 partnerships in total in 2007–08				
	Low usage of forums	**Medium usage**	**High usage**	**Very high usage**
No. of messages	0 – 100	100 – 300	300 – 500	Over 500
No. of partnerships	19	29	15	11

was accessible and reliable for these two types of school. We also conclude that the volume of messages is just one means of measuring success, and next we consider what other factors need to be taken into consideration.

Measuring collaborative learning in the construction of wikis

The researchers recognised that simple counting of messages posted into Moodle forums was not sufficient to give a picture of the level of collaboration between schools. Examination of the content of messages was essential in order to place discussions into different levels of collaboration. Salmon (2000), drawing on evidence in higher education, divides discussion into five levels ranging from basic through to the level of critical thinking and metacognition, as follows:

- Level 1 is the most basic level of discussion where contributors are introduced and are beginning to find conference (online discussion) areas.
- Level 2, described as Online Socialisation, is where greetings are exchanged, there are signs of accepting the online environment, but no information on course content is exchanged.
- Level 3 is defined as Information Exchange. Comments are made about finding information. Interaction with course content takes place, which leads to participants learning.
- Level 4: Knowledge Construction. At this level, ideas are expressed. Participants respond constructively to ideas and their application and are now learning from each other.
- Level 5: Critical Thinking and Metacognition. Participants are now thinking about what they are learning and are challenging each other

Salmon's research had been carried out with adult learners who were interacting with pre-determined course content. We wanted to examine the actual interaction between pupils and between teachers and consider whether Salmon's model was appropriate for teachers and younger learners, especially when they were not engaging with existing online content but were effectively 'building knowledge' through investigating a curricular topic and presenting their findings in a shared 'work space'. In other words, we needed to look beyond the content of the messages in the forum to an analysis of how the teachers used this forum for planning and review and how the pupils engaged in knowledge construction in their wikis.

By checking the 'history' of wiki pages it was possible to see who had been editing pages, and on what date. Through analysis of the difference between one version of the wiki and the following version, and by knowing the names of the editors and from which school they came, it was possible to determine the level of input of the two schools. In this way, the amount of collaboration could be measured in the wikis. This enabled us to see four different levels of wiki usage.

- Stage 1. Wiki produced by one school only.
- Stage 2. Evidence of contribution by both schools, but wiki pages totally separate.
- Stage 3. Creation of linked pages by both schools.
- Stage 4. Contributions from one school modified or added to by the other school. This stage could be considered as 'knowledge construction in wiki format'.

Examples of Stage 4 work were found in a partnership which had based their project on a study of the seventeenth-century Plantation of Ulster where Northern Irish, mainly Protestant, pupils had explored this controversial topic from the perspective of the native population and the 'southern' students from the point of view of the Anglo-Scottish settlers. Analysis of the interaction in the forum made clear that the presentation of historical data by both groups of pupils developed both knowledge of self and knowledge of others in addition to knowledge of the topic. We discuss the significance of this in the following section.

Using the categories of stages above, we were able to arrive at an overview of schools' experience of using wikis (see Figure 1).

In 2006–07, 56% of schools were able to create a wiki and of these, 24% or almost one in four were able to reach the most difficult and complex levels of collaborative learning. It should also be noted that these more 'advanced' levels of joint work were as likely to be found in primary schools as in post-primary schools. This data was shared with teachers in September 2007 and used to support schools to create more elaborate wikis in 2007–08. In follow-up research carried out in 2007–08, it was found that 76% of the teachers used these collaborative wikis for sharing information about the topics the pupils had been researching.

When wikis were used this encouraged a stronger sense of collaboration and teamwork amongst pupils.

We recognise that there are limitations to the model presented here in that it is possible that one partner might have created a very sophisticated wiki with no input from the other school. However, since our intention was to give teachers a clear framework for both schools to develop a collaborative learning model, we felt that some simplification was warranted.

Of the teachers who used wikis during 2007–08, there was an increase from 16% to 40% in those whose work reached the more sophisticated levels of collaborative

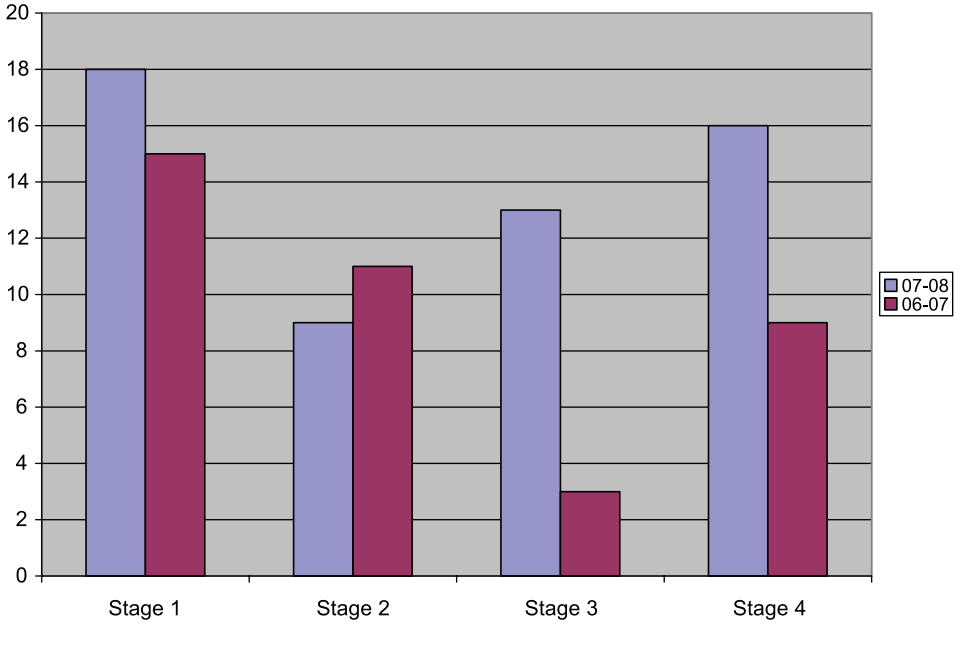

Figure 1. Wiki use comparison 2006–07 and 2007–08.

learning, compared to the previous year. We attribute this increase both to the experience of teachers and to the fact that levels of collaborative learning had been made explicit as part of the professional development provided by the programme team.

Our preliminary conclusion, therefore, was that a modified version of Salmon's five-stage model of collaborative learning was a useful device for enabling teachers to think carefully about the nature of the collaborative work they were planning.

Broader definitions of 'success' in collaborative learning

Given that many teachers see the social, attitudinal part of Dissolving Boundaries as being at least as important as the curricular side, we felt that we needed a revised version of Salmon's model to better capture the different ways in which collaborative learning took place. This model takes account of the ways that teachers use Moodle, video-conferencing and the optional face-to-face meetings of pupils to foster collaborative learning and is based on the recognition that it takes time for teachers to develop the skills and expertise to use this form of blended learning.

Our base-line, what nearly all schools were able to achieve, is characterised as follows:

- Level 1: Teachers use a variety of means (e.g. Moodle, video-conferencing and face-to-face meetings) to establish a working partnership with the other school where pupils exchange personal and curricular material and where teachers use appropriate technology to plan and monitor their pupils' work. This stage is marked by extensive use of communication but with limited evidence of collaboration.
- Many schools reach an intermediate level – Level 2. Here there is evidence of *regular* social and/or curricular interaction, including the sharing of ideas and perceptions by pupils. There is evidence of collaborative learning. This is a valuable building block towards more advanced collaborative learning which we see as having some or all of the features of what we call Level 3 interaction.
- Level 3: Evidence of challenging knowledge construction and/or attitudinal change, pupil ownership of the learning process and/or pupil reflection on the learning process which includes elements of metacognition ('learning about learning').

In summary, our analysis of what actually went on in the construction of the wikis and an acceptance that the purpose for which collaborative learning occurred was social as much as intellectual, has led us to a modified version of Salmon's model which we feel has value both in terms of measuring the effectiveness of a programme like Dissolving Boundaries and in terms of its use in teacher professional development.

When we analysed what we identified as the most advanced examples of collaborative work we were able to reach the following conclusions:

- Excellent work can be produced by children as young as eight or nine when their teachers have a clear understanding of the technology, know how joint work can be fitted into the curriculum and communicate regularly.
- While social interaction between pupils is important, effective curricular work can be carried out if teachers have a sound structure in which the respective contributions of both sets of pupils is established at an early stage.

- Some of the best work involved the use of several technologies and a face-to-face meeting which was linked to the overall work plan.
- Links which seek to encourage knowledge of others and of self are often associated with the early development of a group identity between pupils and this can be fostered by details like giving the inter-school group a name and encouraging the pupils to correspond as a group rather than as individuals.
- Teacher professionalism lies at the heart of the best work. This term embraces a wide range of skills, competences and values. As part of this process, the emerging model of collaborative working was discussed with teachers at a planning conference after the data for 2006–07 had been collected. Making this explicit helped many teachers improve the quality of their work.

Promoting and sustaining collaborative learning

The final research question explored the factors that enabled some partnerships to engage in the more advanced levels of collaborative learning.

Social interaction, group work and teacher planning

Our evidence leads us to the conclusion that we need to consider together the place of social interaction in collaborative learning and the need for planned stimulus in the organisation of groups.

As we noted earlier, social interaction between pupils is indeed very important and some teachers, particularly in Special schools, see this as being the main reason for collaborative learning. We also saw that some of the most sophisticated work between pupils, whether at primary school or in the older age groups, relied heavily on a strong element of social interaction, especially between groups. The trust-building which emerged from regular high-quality social discourse meant some pupils were able to criticise each other's work constructively or engage in difficult issues related to identity. In other words, it is very difficult for teachers and their classes to reach the highest levels of collaborative learning without regular social interaction.

However, we also saw that where the goals of collaborative learning are defined mainly in terms of cognitive knowledge construction, such as a detailed plan for the investigation of global warming with older pupils or the use of mathematics to set up a cross-border online tourist agency, social interaction between pupils is less important if the teachers have developed a very clear plan for the work to be carried out. We underline this point to emphasise that regular interaction between teachers, using whatever technologies are available, for planning, monitoring and evaluation of pupil work is absolutely essential for effective collaboration.

Technology: an enabler or a barrier?

As we noted above, previous research suggests that technology can be a determining factor in either ensuring success or causing failure in work of this sort. We discuss this issue by looking in turn at video-conferencing and Moodle.

Video-conferencing. Just over half of all schools in the programme reported that they had used video-conferencing in the academic year 2006–07. Those who hadn't were

almost entirely the primary schools that had just joined the programme in September 2006 and were awaiting a solution that would connect the broadband network in Northern Ireland to the mixed ISDN and broadband provision in the Republic of Ireland. In fact, technical testing of a suitable product was only complete by the end of the school year with an anticipated rollout from September 2007.

In the schools that did have video-conferencing, it was teachers in primary and Special schools who found it extremely valuable. This was 'an exciting medium to exchange views and get to know partners', it gave 'weaker pupils a chance to communicate without depending on text' and it made a real impact on them. 'Just the sheer expression on the face and reaction on someone talking to them' was how one teacher put it; another said 'when they met face to face, they were more willing to speak and had built up a relationship over the video-phone'. Its immediacy and its visual appeal led one teacher to summarise a group discussion by saying that 'I don't think this work would survive without it'. Another, working in a Special school where pupils had behavioural problems, described how a song writer had joined a video-link to sing with his guitar, an experience that improved levels of focus and concentration. In another Special school, a teacher was, in his own words, 'shocked' at the ability of a child to be able to retain substantial information and present it perfectly to camera. It was as though suddenly 'he had a sense of purpose, a sense of meaning'.

So, overall, in spite of some technical problems, video-conferencing worked well in schools where the timetable and the location of the equipment meant that it could be smoothly integrated into the working day. One of the teachers said that when the pupils understood the need to speak clearly, they moved easily between social interaction about themselves, their partners and their schools to books they were reading and to their collaborative work. They had to decide who was going to do what in their wild animal project and as the teacher said, 'they had to give reasons and justify their views … they had to back up their ideas if they wanted that idea to be taken on by the group'. Another, working in a primary school observed that it was 'very useful for collaborative working … it was used for suggesting verbs and adverbs' in a project about the novel *Charlotte's Web*. The development of oracy was commented on by another teacher who said that the slightly older children in their partner school 'were actually pulling our kids up, they were giving one-syllable answers but through time they began to pick up to their level'.

But video-conferencing was just as important for teachers as for pupils; one typical teacher comment was 'it can really focus to video-conference every second week so you are in constant contact with the teacher'. We conclude from this that understanding and use of video-conferencing by the teacher is a key factor; where teachers themselves made regular use of this medium for discussion with their partner teacher, they were more likely to use it in creative ways with their pupils.

Moodle. The other ICT tool that teachers and pupils all had access to was the web-based learning environment Moodle. As we explained earlier, Moodle is both a forum for the exchange of views and a safe environment where pupils can post and develop information in a wiki. In discussing each of these in turn, it is also worth noting that teacher use of Moodle was shaped by their training in its use, their overall ICT competence and their access to hardware in their schools. Overall, it is fair to say that teachers in Northern Ireland currently have a slightly better pupil–computer ratio than their colleagues on the other side of the border.

The forum. As we noted earlier, Moodle was completely new to many teachers in 2006–07 and nearly all were able to attend 'just-in time' training. We have identified four significant findings here.

First, a majority of teachers in primary and Special schools found that exchanging messages in a forum was easier technically than constructing a wiki. One teacher said:

> I would agree that the wikis were very difficult to negotiate but they are very creative and I personally think that worked better than the forums.

Secondly, there were many positive comments about the use of the discussion forums: one teacher described the pleasure at watching her class 'logging on' in the morning and running to the staffroom to tell her 'Oh I got a message, I got a message'. 'It is difficult to explain a child's excitement when she receives a message'. Another teacher, working in what she called a deprived area in the west of Ireland, said 'the fact that my class knew there were children in a school in Ballymena sending messages to them … I can't emphasise the excitement enough it was just fantastic'. In another case, where a teacher was working with 7–8 year-olds who found wikis too difficult, the forum led to a 'huge improvement in their structuring of sentences'.

At a time when it might be easy to be rather blasé about the ubiquity and the universality of digital communication, these comments are useful reminders of the power of such interaction on a wide range of young people and their teachers.

The third issue that emerged from teacher comments was their frustration at being unable to carry out some of the things they wanted to do, like uploading pictures, a problem which has been rectified in the latest version of Moodle.

Finally, teachers noted that managing pupil work in groups in the forums was extremely important and quite difficult; some worried that individual pupils were being ignored in these exchanges or that word-processed text risked excluding some members of a group. The best response to these legitimate concerns can be found in the way that some teachers directed the groups to write as a group, with all of them contributing to what was presented.

Wikis. While most teachers were able to make a start in moving from the forum to the wiki, it was a minority that was able to make full use of this application to develop collaborative learning in 2006–07. This seemed to happen most often when the teachers either had a significantly high level of competence in ICT, when both teachers were given one-to-one training or when they saw early on the central role that the wiki could play in curricular learning and made it a priority for their own professional development. Many of those that went down this road clearly benefited from a 'planning matrix' developed by the research team that provided a step-by-step guide. We have also noted how the percentage of teachers able to use the wikis for more advanced work increased significantly in 2007–08.

Teachers noted that amongst their pupils, those with access to the Internet at home 'seemed to warm to the whole thing' and, among some secondary pupils, their experience with other social networking sites like Bebo, MySpace, Friendster and so on gave them confidence to use the instant messaging facility in Moodle to work more effectively. Some teachers clearly valued the fact that all wiki work done was in a protected environment which was monitored and safe.

Overall, we can conclude that although the technology was at times a frustration for teachers and in some cases put limits on what they felt confident in doing, there

was a sufficient range of digital tools in video-conferencing and forum discussions in addition to wikis to offer all teachers the means of achieving some level of collaborative learning. Where teachers were able to deploy all the tools, it led to outstandingly innovative and creative work.

Teacher professionalism and school ethos

In this final section of this paper, we examine whether 'success' was more likely to occur when 'meaningful pedagogical models were implemented' (Ligorio & Veermans, 2005, p. 271) and whether 'structural conditions at the level of the school organisation were more important than teachers' attitudes or expertise' (Ligorio & Van Keen, 2006, pp. 124–125).

To take the first of these, we can say that the teachers who were involved in some of the more advanced collaborative learning certainly had a clear rationale for what they did and recognised the considerable benefits that arose from this kind of work. While they did not use terms like 'constructivism', their analysis of what collaborative learning was included reference to the centrality of pupils creating knowledge, whether that knowledge was cognitive, affective or a mixture of both. Our evidence also indicates that teachers need time and experience in this kind of work to be able to stand back from the detail of managing what their pupils do to undertake the kind of critical reflection that can lead to metacognition. One teacher put it like this:

> It takes time to do things in a more innovative way but I have absolutely no doubt that the benefits outweigh the drawbacks with the deeper learning that takes place.

The second of the issues from previous research suggests that 'structural conditions in schools', which we take to mean school ethos and attitude of senior management, are more important than teacher expertise or attitude. Our evidence provides only a partial endorsement of this earlier work.

One very clear message from our evidence is that collaborative learning between schools is often, but not always, associated with a tradition of collaborative learning *within* the schools. We noted examples of this earlier when we analysed teachers' understanding of what collaborative learning involved. We also agree that the role of senior management in schools is extremely important in supporting teachers engaged in work that can often disrupt the normal timetable. We had impressive examples of head teachers showing their commitment to the programme by attending either the planning conference in September or the review conference in April.

Our evidence does not, however, lead us to the conclusion that these 'structural conditions' are more important than teacher expertise or attitude. One highly significant finding from our work was that there was only one comment from a teacher indicating that it was the *personal relationship* between teachers which mattered most. What emerged far more strongly was that it was their *professional relationship* which had the most bearing on learning outcomes. This relationship implied a readiness to develop sufficient technical expertise to make the link work, to plan flexibly in ways that fitted the work into the emerging curricula in both jurisdictions and to check pupils' online interaction. One teacher said of this: 'I just check in the morning and see if there is any response and I have never had any problems'. In other words, a new way of working was being adopted in the interests of ensuring that the link worked well. Clearly, there is something here which is about having a professional attitude so

that pupil and teacher messages are responded to promptly. When teachers were provided with the evaluative data about levels of collaborative learning after data had been gathered in 2006–07, it helped them to develop more sophisticated wikis in 2007–08.

In summary, teacher professionalism, in the context of collaborative learning, means displaying the right values, using craft knowledge to turn big ideas into realistic classroom practice and engaging in the kind of critical reflection which can get the best out of imperfect technology and adopt innovative ways of working. We identify this as being the single most significant factor in successful partnerships. This finding resonates with the work of Riel and Becker (2000) and Stenhouse (1975) who identified the most successful teachers as having precisely this capacity to develop an extended professionalism. We suggest that it is ICT which acts as the stimulus for critical reflection about learning, particularly in cases like this one where partnerships outside the school may challenge existing models of teaching and learning.

This conclusion has implications for professional development and indeed for the regulation of teacher competences at both pre-service and in-service levels; a workforce for the twenty-first century serving schools that are digitally linked more closely to their own communities and to those in neighbouring or distant regions, will need continued support in this emerging aspect of teacher professionalism. A key element in this support will be the capacity to think through the values attached to different kinds of knowledge and the ability to reflect on different levels of collaborative learning.

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