

Title Page

Effects of continuing professional development on group work practices in Scottish primary schools

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ABSTRACT This study investigated the effects of a continuing professional development (CPD) initiative that provided collaborative group work skills training for primary school teachers. The study collected data from 24 primary school classrooms in different schools in a variety of urban and rural settings. The sample was composed of 332 pupils aged 9-12 years old, and 24 primary school teachers. Results indicated the CPD initiative had a significant impact on the attainment of pupils in science. In addition data indicated that the CPD promoted effective discourse and pupil dialogue during science lessons. Pre-post test observation scores were significantly different in terms of children giving of suggestions or courses of actions, offering of explanations, and telling someone to say something or carry out an action. Increases in effective dialogue were significantly correlated to increased science attainment and teacher evaluations of the impact of the CPD were positive. Significant correlations were found between teacher evaluation of impact upon pupil learning and increased attainment in science. The design and structure of CPD initiatives and the implications for practice, policy and future research are explored.

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Introduction

The project researched the effects of continuing professional development (CPD) in collaborative group work on classroom practice in primary school settings. The research took place in Scotland in schools from eight different local authorities. Selection of schools for the study sample ensured the sample was composed of a number of schools from rural and urban locations as well as classes composed of pupils the same age and pupils vertically mixed in age. The sample therefore represented those types of school typically found within the Scottish education system.

The aims of the project were as follows:

- To identify representative samples of teachers in Scottish primary schools and offer teachers in these schools the opportunity to engage with a programme of CPD designed to support them in planning and implementing group work activities for children. The teachers were provided with science curriculum materials to facilitate the introduction of effective group work practices within the context of their classroom.
- To collect data on attainment in primary science and assess the impact that the CPD initiative could have on cognitive development in this area.
- To record changes in classroom discourse and dialogue that may be related to the CPD programme.
- To evaluate the effectiveness of the CPD programme at facilitating changes in the classroom practice of participating teachers.

The role of the teacher in organising group work

Peer learning can be an effective method of learning and teaching. In a meta-analysis Rohrbeck et al (2003) reported large effect sizes for 90 peer learning interventions. However, whilst teachers often reported that they utilised group work as a teaching and learning strategy in the classroom, previous work reported that this 'group work' often actually involved working alone or listening to teacher instruction (Tizzard et al, 1988; Galton & Williamson, 1992; Galton, Hargreaves, Comber & Pell, 1999). Wilson, Andrew and Sourikova (2001) reported that classroom observations of mathematics lessons indicated that although children were identified as a 'working group', in practice, each child generally undertook work independently. In such learning contexts, children did not get the benefits of the social aspects of learning in a group and talk in these settings often did not enhance learning. Therefore classroom

working arrangements put in place by the teacher can influence the effectiveness of group work.

Science is reported to lead itself to classroom activities that can create effective contexts for undertaking group work (Howe et al 2000) and the use of group work learning contexts has been shown to raise the attainment of pupils (Slavin, 1987; Lou et al, 1996; Gillies, 2004; Topping, 2002). In a survey of 804 schools, Hallam, Ireson and Davis reported that 34 % of these schools indicated that they utilised group work as a strategy to promote increased attainment. (Hallam, Ireson & Davis, 2004). An essential element of group work learning contexts is the quality of talk that takes place. Co-operation through talk enables learners to reconstruct and elaborate their ideas through peer dialogue (Bereiter, 2002) and is the primary tool for the joint construction of knowledge by teachers and learners in learning contexts (Barnes & Todd, 1977; Mercer, 1996). Groups composed of students who gave more explanations were found to be most effective at promoting attainment in cooperative learning contexts (Slavin, 1996).

Effective CPD

In Slavin's view, CPD is vital if co-operative learning is to be implemented effectively. In order to develop successful co-operative learning strategies through exposure to CPD teachers need access to training that includes: (1) developing understanding of the theory and philosophy of co-operative learning; (2) practical demonstrations of co-operative learning methods; and (3) ongoing and collegial support at the classroom level (Slavin, 1996). A report by Ofsted commented that CPD on peer-assisted learning in England was reported to have raised attainment in underachieving year 1 pupils who subsequently went on to exceed the targets they were set for their end of Key Stage 1 assessment (Office for Standards in Education (Ofsted), 2004).

Best quality professional development for teachers aims to enhance competence, expectation, and impact upon classroom practice (United States Department of Education, 1996) and programmes of CPD that fail to address these issues are likely to have less impact upon classroom practice. Conlon's (2004) work on the New Opportunities Fund for ICT training for teachers in England provided an example of how a CPD initiative failed to maximise impact upon the professional practice of teachers. It is essential therefore that, since CPD covers a wider range of professional learning, it should have impact upon classroom practice as one of its intended outcomes. Harland and Kinder (1997) outlined a typology of CPD outcomes that included:

- Material and provisory outcomes – Teachers are provided with physical resources for classroom use.
- Awareness outcomes – Teachers develop new awareness of pedagogies and undergo conceptual shifts away from previous assumptions regarding the content or pedagogies used for effective delivery.
- Affective outcomes – Teachers adopt positive meaning to value the changes proposed by the CPD. The increased affective response of the teachers to the new learning supports them through periods of uncertainty that occur whilst changes in practice are implemented in the classroom.
- Motivational and attitudinal outcomes - Enhanced teacher motivation and attitudes are particularly important precursors to subsequent impact upon professional practice.
- Knowledge and skills outcomes – Development of critical reflexivity to both curriculum content and pedagogy.
- Impact on practice - Impact upon the professional practice of the teachers in respect of the frequency of science teaching, planning, organisation and management of activities and the management and nature of interactions in the classroom.

Little has argued that CPD programmes that are delivered as stand alone workshops and fail to engage participant teachers as active partners lack focus, intensity and continuity, and have less impact in respect of changing classroom practice (Little, 1993). Recent CPD initiatives in the United States and elsewhere have been closely linked to school development planning. In a sample of 52,400 teachers from the United States it was reported that 89% of CPD initiatives were linked to school improvement plans (Choy et al 2006) and CPD that involved teachers as collaborators in planning and implementing initiatives was reported to have more potential to impact on the quality of teaching and student learning (Hawley & Valli, 1999).

In CPD initiatives designed to enhance school based mental health provision it was found that a blend of best practice and perfect lesson systems (good practice being carefully modelled for teachers) were most effective. In a sample of 230 teachers studying on a post graduate certificate in education over a two year period, 95% reported their satisfaction with this approach as high or very high (Freeman et al 2003) and similar approaches were reported to be effective by the majority of 36 teachers spread across 28 schools. In this study teachers reported that the CPD left them feeling pedagogically empowered and able to be an agent of change in their classroom setting (Thornton, 2004). CPD can be demanding when participants are working full-time in stressful contexts. In a sample of 17 students

undertaking the Scottish Qualification for Headship (SQH) coping with time demands of SQH alongside a full time job in the senior management team was seen as problematic by participants (O'Brien & Draper, 2001). For this reason it is desirable for CPD to achieve the right balance of pedagogical theory and practical exemplification so that participants feel that it has a role to play in their professional development. CPD is reported to be most effective when this balance is achieved and teachers are actively engaged in researching their own professional practice (Campbell, 2003). This facilitates the development of good practice in schools and is a cornerstone of policy in both England (Department for Education and Skills, 2003) and Scotland (Scottish Executive, 2003).

Cordingley et al (2003) reviewed 72 studies of CPD. They concluded that when CPD allowed teachers to relate inputs to existing and future practice:

- greater confidence gains were experienced by teachers,
- teachers increased in their belief that they had the power to make a difference to the learning of their pupils,
- teachers became enthusiastic about collaborative learning, despite some initial anxieties regarding being observed and receiving feedback,
- teachers had a greater commitment to changing practice and a willingness to try new techniques and methods.

The evaluation of the effectiveness of CPD initiatives is reported to be best achieved by gauging the reactions of participants, assessing learning through evidencing impact on classroom practice, and through measurement of student learning outcomes (Guskey, 2000). However, the evaluation of CPD has been reported to be problematic. Hicks and Hennessy (2001) reported that this was because CPD was often not evaluated and even when it was, it was difficult to operationalise effective evaluations. If CPD programmes only evaluate participants' reactions to the programmes, then they fail to investigate the other indicators of impact that Guskey lists (Retallick & Mithani, 2003). Therefore, it would appear to be incumbent upon researchers to address the question of how to design and implement effective CPD evaluation and correlate these evaluations with observable impact on professional practice. This is reported to be a key challenge to researchers who would evaluate CPD. In a sample of 49 teachers who had recently completed CPD, the majority placed significant importance on the ability of CPD to impact upon classroom practice (Powell et al, 2003).

The impact of CPD on classroom practice has been the subject of debate for a number of years. In England, Ofsted (2004) emphasised that its inspections of CPD run under the Teacher Development Agency (TDA) In-service Education and Training (INSET) initiative should include assessment of the quality of training and the impact of such training. They specifically drew attention to the impact of CPD in raising attainment in pupils, the provision of evidence of significant and demonstrable impact on classroom practice, and the critical use of quality assurance measures to gauge the responses of the participants of CPD and those who manage them). Demonstrable impact from INSET schemes is defined by some as raised attainment in pupils (e.g. Soulsbury & Swain, 2003). It is reported that when formal assessment of the impact of CPD on pupil attainment and classroom practice are not systematically measured then CPD is less successful for teachers (Daly, 2007). The Teacher Development Agency in England (TDA, 2007) suggest that impact should be assessed: on participants (in terms of self-confidence and motivation, professional practice, subject knowledge and understanding, values and attitudes, career progression, and reflectiveness and readiness to take risks and innovate); on pupils (self-esteem, engagement, attainment and attendance/exclusion rates); and the whole school (culture and ethics, willingness to share good practice and school improvement).

Research questions

The research project aimed to answer the following research questions which were designed to research and assess the impact that the CPD initiative had on the attainment of pupils in science and on the classroom practice of teachers. The questions were also designed to explore the affective response of the teachers to the initiative.

1. Were there observable changes in classroom practice in schools that could be linked to the CPD initiative? In particular what were the effects on:
 - a. Attainment in science?
 - b. Pupil dialogue that could promote effective learning?
2. How did teachers evaluate the CPD provision and were there correlations between their evaluations and observable changes in classroom practice?

Methodology

A methodology was adopted by the research team that measured changes over time during the study period. Pre- and post- test measures were used to assess the impact that the CPD may have had on cognitive outcomes for children and the nature and type of interactions that were taking place during the teaching of science. Schools in Scotland are diverse in nature and structure. The sample was designed to capture this diversity and was composed of an equal number of schools drawn from rural (associated population under 10000) or urban areas (associated population over 10000) and with classes that were composed of pupils who started school in the same academic year and those who were composed of pupils who started school in differing academic years (composite classes).

Design

A pre-post design was coupled with gathering process data regarding implementation integrity. The study took place during the period of one academic school year between August and June. Initial contact was made with the schools in August. Schools were selected for the study by September and data was collected from 24 study classes. Pupils' attainment in science was measured by pre- and post- test and observations regarding the extent to which group work was being utilised in science learning contexts were undertaken. Teachers from study classes were recruited to a CPD programme that focused on enhancing group work practices in the classroom setting. The first CPD day took place for teachers in October and pre-intervention data was collected at this stage. Teachers used structured techniques to help develop social and communications skills related to effective group work skills between October and December. The second CPD day for teachers took place in February. Teachers taught two science group work topics in their classes between February and May. A final CPD day for teachers was held in May. Post-intervention data was collected in June.

Sample

Questionnaires were distributed to schools in eight local authority regions in central Scotland. The local authority regions were selected on the basis of similarity in socio-economic conditions and population demography and sample classes were selected from a pool of 24 interested schools, classes being chosen on the basis of fitness for purpose. It was not the intention of this study to produce a randomised controlled sample, but rather to look for implementation effects that

could be linked to the provision of CPD. The number of pupils in the sample who completed both the pre and post attainment test was 332. 130 of these pupils were selected for detailed observational analyses and 24 teachers completed CPD questionnaires.

Intervention

Continuing professional development for teachers The CPD programme was carefully designed to take account of the essential elements of CPD as outlined by Harland and Kinder (1997). Therefore, there was emphasis on the pedagogy of effective group work. In addition, issues of embedding group work within the science curriculum were explored. Teachers were encouraged to reflect critically on their professional practice and consider how the proposed new pedagogies could be embedded in their classrooms. The CPD programme took place over three days spaced out over one year and the cost of employing supply/substitute cover to allow classroom teachers to attend these CPD days was recovered by participating schools. The main aim of the CPD was to enhance pedagogical approaches to group work adopted by the teachers. To achieve this, the CPD programme focussed on a number of issues that highlighted how the effectiveness of group work could be influenced. Materials were adapted for use in a Scottish context from those developed by the team looking at social pedagogical research into grouping (SPRinG) (Baines, Blatchford & Kutnick, 2003). In addition to developing the pedagogical awareness about effective group work teaching skills, the CPD had a number of aims:

- To enhance teachers' ability to develop generic group work skills in children. The teachers were provided with a manual that included about 20 hours of classroom based group work training activities for children. The manual focussed on the development of social and communication skills in pupils that would facilitate effective group work. Teachers were also provided with advice on troubleshooting if the learning contexts that they established did not function effectively.
- To exemplify how generic group work skills could be incorporated into the science curriculum (particularly two science topics - states of matter and forces and friction). The science curriculum packs included lesson plans and teaching materials for approximately 40 hours of classroom based activities.
- To ensure the teachers had subject content knowledge and confidence to deliver two science units.
- To familiarise the teachers with instruments and measures that would be utilised.

Instrumentation

Attainment measures Measures of standard attainment in science were completed utilising the Performance Indicators in Primary Schools (PIPS) instrument for 11 and 12 year old pupils (Curriculum, Evaluation and Management Centre (CEMC), 2002a). The PIPS test was administered to 11 and 12 year old pupils from study classes at pre- and post- intervention and are tests of curriculum attainment developed by the CEMC at the Durham University which are annually reviewed for validity and reliability. They are widely used (thousands of schools in over 25 countries). The PIPS instruments have been developed such that the average standardised score for the 11 and 12 year old children was 50 and this necessitates a conversion from the raw score to a standardised score. The PIPS instrument was administered by the teachers in their own classrooms in accordance with the Teacher Administration Instructions (CEMC, 2002b) and standardised scores are presented in the data set. The PIPS instrument assessed science attainment by means of a 43 item test, each item having 4 multiple choice options. The PIPS instruments had high figures for reliability and validity. Cronbach's alpha scores previously reported from a study involving 642 Primary 7 pupils in Scottish schools of the PIPS assessments used in this study were $\alpha=0.89$ (Merrell, 2005).

Observational analysis The observation schedule used was developed from one previously utilised by the SPRinG team (Blatchford, Kutnick, Baines & Galton, 2003) and this schedule was supplemented with other behaviours reported to promote interactive cognitive activity (King, 2000). Two observations of group work lessons were undertaken (pre and post intervention). Prior to the first observation, 6 children were randomly identified from the class list and observations were based on a 40 second window (12 to focus in, 16 to observe, 12 to record). The observations started with the first of the preselected target children and eight successive windows were observed and recorded for that child before moving onto the second target. The second child observed was another child from the same group as the first, of the opposite gender. Eight successive windows were observed and recorded for this child before again moving onto the third target. The next preselected child was the third target. Observation now cycled between preselected children with the same pattern of gender target change between observations. For each target eight windows were observed and recorded before moving on. Scores are presented as the total observed behaviour in each category (min=0, max=8). The teachers were asked to provide a lesson that had a problem-solving context for the first group observations. The same six children were observed during the

second observation session, so that longitudinal data on interactions was obtained. The second observation took place during one of the science lessons provided to the teachers as part of the intervention. This meant that in both the pre and post test observation lessons, children were only observed when they are actually supposed to be doing group work. Observations were only recorded during the groupwork sections of the lessons (not during briefing or debriefing). Multiple codes were used where appropriate for all dialogue elements falling within the same observation period. For example if the target child gave an instruction and then asked an open-ended question, both were recorded. For simplicity, each interactant was recorded once only during a given window no matter how many times the target child engaged with an interactant. For example if the child started by talking with another child in the same group, then asked the teacher a question, and then returned to talking with the first child, this would be recorded just as the child talking to someone in the same group, and with the teacher. Only data from children who were present in the initial observations and the second observation visit in addition to completing both the pre and post test PIPS tests is presented in the paper. The number of children observed from each sample for whom pre and post test attainment data was also available was $n=130$.

Observations were undertaken by two research assistants employed for data gathering purposes for this project. Training was given to each research assistant. Reliability trials were undertaken prior to the first observation being undertaken. Each research assistant independently coded 8 successive windows for each of 8 different target children, noting the interactants and the frequencies of each type of dialogue (giving 64 separate sets of coding each). Data indicated agreement at the following percentage levels for the main dialogue codes recorded:

- Child suggested an idea or course of action, or otherwise makes some form of statement that someone else could have disagreed with (88%)
- Child explicitly disagreed with a suggestion or explanation offered by another (97%)
- Child offered an explanation to a proposition (98%)
- Child referenced back to a previous suggestion or explanation, irrespective of originator (98%)
- Child acknowledges previous statement of other and adjusts own to include content (98%)
- Child told someone to say something or carry out an action (89%)

- Child asks open-ended question that directs attention to something not yet considered (97%)

CPD evaluation questionnaire A questionnaire was designed to allow the teachers to evaluate the CPD initiative. The questionnaire was completed at the end of the third CPD day and teachers placed it in a collection box before departure. It was a 47 item questionnaire which asked teachers to numerically evaluate and provide written comments on their perceptions of the initiative. Numerical evaluations involved teachers responding to specific questions indicating their response on a four point scale. The questionnaire had two sections. Section one had 33 items and asked teachers to evaluate the materials and support that they received. In this section, the numerical scale used was from 1 (not at all valuable) to 4 (very valuable) for 8 of the responses and teachers were asked to respond with an extended written answer to 25 items in section one.

Section two contained 14 items and asked teachers to evaluate the impact that the initiative had on their classroom setting. In section two the numerical scale used was from 1 (completely disagree) to 4 (completely agree). This numerical scale was used to record teachers' responses to 10 items and an additional 4 items in section two asked teachers to respond in a written format to identify the strengths and weaknesses of the CPD programme. The numerical responses of teachers allowed four sub-scales scores to be computed from the questionnaire giving scores out of: 16 for the teacher evaluation of training (4 items); 16 for the evaluation of materials (4 items); 12 for the teacher evaluation of classroom impact (3 items); and 28 for the teacher evaluation of impact on children's learning (7 items).

Data handling and statistical analysis Two way repeated measures within sample ANOVA was utilised to analyse impact on attainment within the sample. Changes in categories of observed behaviour were analysed using two way repeated measures within sample ANOVA. Pearson correlations were used to determine relationships between changes in observed behaviours and impact on science attainment, between teacher evaluations and changes in attainment. Attrition rates were low and there was no evidence that attrition significantly biased the samples.

Results

Impact on attainment

Table 1 reports the average pre-post intervention science attainment scores obtained from 11 and 12 year old pupils. Observed gains were

statistically significant ($F=55.19$, $df(1, 331)$, $p<0.0001$). A difficulty encountered with data collection was that not all pupils in the study classes were 11 or 12 years old and these pupils did not complete the PIPS test. This was because half of the sample was drawn from classes composed of cross age pupils and in these classes pupils who were aged from 8-12 were taught in the same classes. In addition not all children completed all the sections of the PIPS at both pre- and post-test. To overcome problems associated with these issues and attrition due to illness and absence, only data from pupils who completed all items on both the pre and post tests are presented and used in the data analysis.

Insert Table 1 here

Impact on classroom interactions

Significant impacts on the nature and frequency of classroom interaction were observed and the results of observational data are presented in Table 2. Two way repeated measure within sample ANOVA were used to determine that pre-post observation scores were significantly greater in terms of children suggesting ideas or courses of action ($F=25.03$, $df(1, 129)$, $p<0.001$), offering explanations to propositions ($F=4.29$, $df(1, 129)$, $p<0.05$), and telling someone to say something or carry out an action ($F=19.42$, $df(1, 129)$, $p<0.0001$) in post-, than pre-intervention observations. There were significant correlations between children suggesting ideas or courses of action ($r=0.325$, $n=130$, $p<0.01$), offering explanations to propositions ($r=0.429$, $n=130$, $p<0.0001$) and gains in science attainment.

Insert Table 2 here

Evaluation of the quality and impact of CPD by teachers

Numerical responses from the evaluation questionnaire were collated into four themes. Scores within these themes added together to give an overall score of quality and impact of CPD. Data presented in Table 3 indicate that teachers evaluated the impact of the CPD positively. Overall the scores assigned by teachers indicated high satisfaction with the CPD initiative and low standard deviation indicates that this satisfaction was prevalent across the sample. There were significant correlations between the teachers' evaluation of impact upon children's learning and the actual increases in science attainment ($r=0.127$, $n=332$, $p<0.05$).

Insert Table 3 here

Comments provided by teachers were analysed using methods described by Wellington (2003). This involved using a 'Constant Comparative Method' and the continuous refinement of categories. This method of analysis involved dividing the data into categories, combining categories where appropriate, checking the fit of categories and finally comparing and contrasting categories. Once categorised, the data (in the form of the issues or comments made by the teachers) were coded. 255 issues/comments were coded and a summary of the coding and main categories is presented in Table 4. Five categories emerged from the data analysis and these categories reflected general perceptions about the CPD programme, the quality of the materials provided by the project, the management and implementation of the project, impact upon professional practice and impact upon children. Issues/comments were grouped within these categories.

Insert Table 4 here

Data indicated that teachers highly valued the opportunity that the CPD programmes gave them to network and share issues/solutions with other teachers and that the project had a positive impact on the ability of teachers to manage group work. Comments indicated that the general group work training materials and the science curriculum packs had both contributed to this. Teachers reported positive impacts on their science knowledge and understanding as well as their pedagogic knowledge. Teachers also reported increased confidence, self-esteem and social skills in children as well as positive impacts on science learning. Some negative comments did emerge. Teachers reported that the project was difficult to fit into the time available and did lead to some difficult choices having to be made. In addition some teachers felt that the assessment load on the pupils was too high. Finally some teachers expressed a wish to have more feedback on the results of the project at the classroom level because they wanted to know how the pupils in their class were doing. Selections of comments provided by the teachers that are illustrative of those made within some of the themes identified are presented below:

CPD programme

'(I liked)..Listening to other teachers' comments and feedback. It was reassuring to know that most people were experiencing similar situations.'

'(I liked)..Opportunity to reflect on practice and compare experiences with others. . (I)..needed confirmations that I was heading in the right direction.'

'Great opportunity to discuss with other staff, current classroom practise.'

'(I liked)..Sharing experiences with others..(It was)..reassuring to find we had experienced similar outcomes.'

These comments illustrated the important emphasis that teachers placed on the cooperative nature of the CPD initiative. The dialogue and sharing of practice with other teachers appeared to reassure teachers and give them confidence to persevere with changing their own practice.

Impact upon professional practice

'The materials given by the group were excellent and made me aware of how my class learned and how they reacted to one another. I was inspired to take the use of group learning into many areas of the curriculum and use it as an effective learning tool. I will continue this into next year, with a new class, and be able to monitor their progress as well as develop a whole host of new skills – not only for the pupils, but for the teacher as well!'

'I have become more aware myself of looking more closely at when collaborative group work really works'

The comments are indicative of a change in the belief structure of the teachers. They started to believe that the group work techniques espoused by the CPD worked. At this point they were able to take ownership of the change in their professional practice, and concomitantly justify why they would want to change their practice.

'I have found the project to be beneficial, not only to the children, but myself and team-teaching colleagues too. We have been able to use many of the suggested activities and they have been fun / challenging / thought provoking.'

'There is a great need for it (group work) to be adopted as a school policy to encourage collaborative and interactive learning from the early years.'

'I gave an INSET day to colleague. (Group work) is something we are hoping to take forward as a school.'

The comments illustrate how the teachers were able to use the lessons learned during the CPD to impact on professional practice of other teachers in their school. Once the teachers were convinced that the technique would work then they became willing to pass on their new professional knowledge to others.

Impact upon classroom practice

'The activities completed have certainly enhanced the children's knowledge and understanding of science.'

'Some (children) now say that they would like to be scientists or that science is their 'good' subject.'

'..pupils gained a real insight into how to help another pupil – other than just supplying them with an answer.'

'The activities provided children with poor reading skills, the opportunity to explore/learn in a practical manner and make a valuable contribution to the group.'

These comments back up the data from attainment tests that children experienced cognitive gains as a result of the project. In addition they show that there may have been shifts in the importance that teachers attributed to the role of discourse and dialogue in their classrooms.

'Children who might have felt 'alone' in class activities were made to 'belong' in a group situation'

'Some 'rocky' children found that group discussion work enabled them to do well, and as a result feel great.'

'(Children with delayed development) .. loved being able to take a full part in the same science work as the rest of the class. It gave them a real boost.'

'The science groups were only a small part of what we achieved. The children benefited from the development of Personal and Social Skills.'

There were.. 'obvious improvements in self-esteem in all the children.'

'Discipline, confidence and self-esteem have all improved, throughout the project.'

These comments illustrate one of the more unexpected outcomes of the research. A number of comments were made that indicated explicitly that there was increased social inclusion as a result of the project. This was an unexpected finding and was not planned for in the original research design.

Discussion

The discussion will focus on the impact of the CPD initiative and will include both the impact on science attainment of pupils and the impact on observed classroom practices. Critical discussion of the evaluative commentary of the teachers will also be attempted.

Statistically significant gains in science attainment were reported in the study sample. In addition there were significant changes in classroom interaction and discourse that were correlated to these attainment gains. The changes in classroom practice were essential to the success of the CPD initiative and teachers rated the CPD initiative positively on each of the four sub-scales used for evaluation (training, materials, classroom impact, and impact on children's learning). These quantitative measures are supported by the evaluative commentary that teachers provided. Comments indicated that the opportunity to share thoughts and feeling regarding the developments with other teachers on the CPD programme enabled teachers to develop a positive attitude towards the changes that would be necessitated in their practice. Once this attitudinal change was established the teachers implemented change in their own classrooms and then started to facilitate change in the classrooms of others.

Teachers responded positively to the classroom materials and their evaluative comments indicated a high degree of satisfaction with the materials. Supported by the materials, it appears that teachers were able to embed new pedagogies into their professional practice. The issue of how to support primary school teachers who may have poor subject content knowledge and a negative attitude to teaching science is a major one for those engaged in CPD for teachers (Parker & Spink, 1997; Touson, 2000). Findings appear to be in-line with those previously reported that to optimise classroom impact then CPD must develop both content and pedagogic knowledge and skills (Parker, 2004). This suggestion would be in-line with Shulman's (1987) pedagogic content knowledge (PCK) model. The PCK model maintains that teachers need to have curriculum content knowledge as well as

knowledge of how to represent this knowledge to learners. As the effects of the CPD were embedded in the classroom practice of the teachers then gains in science attainment were promoted. This was linked to more effective discourse/dialogue at the classroom level. The development of content knowledge and pedagogical theory provided a good basis of professional development. However, in addition to this the provision of support materials and collegial collaboration appeared to remove the fear of failure in teachers and mistakes and issues were seen as learning opportunities. In their written testimonies teachers reported favourably on the initiative. They used words such as 'enjoyed', 'benefited', and 'well received' when evaluating the CPD and associated implementation of group work in their classroom. This could be indicative of enhanced motivation and attitudes towards the teaching of science. Fewer patterns emerged amongst the negative aspects of the CPD evaluation. These issues related to resource availability in schools, and in one case to lack of differentiation in the materials. Some concerns were also raised in respect of the deleterious effect of participation in the intervention for pupils. A minority of teachers found it difficult to include isolated pupils. In three instances these comments referred to a child who had autism and this is an issue that future attempts to embed peer learning may wish to explore more fully.

Nearly all teachers made comments regarding the need for suitable materials to support CPD, and how important the opportunities were to share information and ideas with other practitioners during the CPD process. Therefore, it may be reasonable to conclude that CPD for teachers may not be enough to maximise gains at the classroom level. There is also a need to develop contextualised curriculum materials that are designed to promote effective use of social pedagogy and group work skills at the classroom level. In addition, those who design and deliver CPD should critically assess how it can provide opportunities for teachers to share practice and network. The research team have developed materials to support the implementation of groupwork in science and these are currently being used in Scotland as part of the new Scottish Schools Digital Network initiative in a managed learning environment that should provide network and communications opportunities in an online format (Topping & Thurston, 2004).

In analysing the results of the study then it is apparent that there is the possibility of a Hawthorn effect being caused by the intervention. Due to the absence of randomised experimental and control samples then claims regarding the impact measures should not be over exaggerated. However, the triangulation of evidence of impact from attainment

scores, changes in classroom discourse and the reports of teachers provided evidence that changes took place at a number of levels.

Conclusion

The research highlighted a number of important issues. It was possible to measure impact in terms of increased attainment for pupils and relate these to the changes in classroom practice that the CPD may have been responsible for. The implications for educational policy and practice are that CPD can facilitate changes in the professional practice of teachers. However, it must be supported by carefully structured opportunities to allow teachers to draw support and advice from each other. The peer learning and support networks established during the CPD appeared to be one of the keys to changing the practice of teachers in the study classes. In addition, in the early stages of CPD it may be advantageous to provide teachers with new curriculum materials that are designed to embed the new pedagogical techniques and help teachers integrate them into the classrooms. In both England (Department for Education and Skills, 2003) and Scotland (Scottish Executive, 2003) the focus of recent school based educational development initiatives have been to enhance the skills of classroom teachers through workplace study. Part of the process of enhancement has been to engage teachers as researchers capable of developing their thinking through university based contact. The aim of such initiatives is to professionalise teaching in order to raise classroom standards and attainment. Teachers effectively become researchers in their own professional practice and this has been shown to be a very effective method of delivering CPD (Campbell, 2003). The findings of this study appear to support these conclusions and illustrate that this ambitious aim is achievable with carefully structured CPD. The 'Curriculum for Excellence' agenda in the Scottish education sector aims to transform learning and teaching in Scottish schools. This study could provide a valuable insight into how to effect change in the working practices of serving teachers as this initiative is developed and rolled out into schools.

It appears clear that in order to maximise impact on children's learning and facilitate change in the professional practice of teachers that teachers need to believe in the new initiative, take some degree of ownership of change, see the benefits of new ways of working for children, receive advice and support from peers and approach subsequent development on a school wide basis (TDA, 2007). This research appears to suggest that peer support from colleagues may

also have an important role to play in this process. Teachers in the sample reported favourably on the process of sharing information, problems, solutions and good practice with colleagues and report that this dialogue appears to be important to the process of professional change.

MacNab (2003) reported that in a sample drawn from 170 Local Education Authority and school representatives, 46% of Scottish schools reported less group work since the introduction of curriculum initiatives in mathematics education. The drop in reported group work may be indicative of teachers losing the ability to apply an effective pedagogical tool in the classroom. This was emphasised by Hutchison (2003) who reported there was a need to ensure that group work was effective in classroom contexts, and concluded that education was not just an activity that takes place in a group, but was a group activity. To have maximum impact it is clear that group work needs to be embedded into the pedagogy and planning in individual curriculum areas and effective CPD provision should be maintained. This is particularly relevant if the skill set to organise effective group work is being lost from the teaching population.

Looking ahead

Follow up work will report on the progress of pupils from the study sample as they make the transition from primary to secondary school. The potential influence that group work skills may have on the success of this transition for pupils, and the ability to run a similar CPD programme for secondary school teachers will be examined and reported. In addition further work is underway to evaluate CPD in paired reading. Impact assessment will be extended to consider the social (self-concept as a reader, social inclusion and self-esteem) as well as cognitive gains. In addition the initial reactions/efficacy of teachers to the proposed CPD will be explored and the extent to which they impact on implementation of new working practices analysed.

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Table 1: Mean pre-post PIPS standardised scores ^(b) of general attainment in science (sd) n=332

	PIPS Score
Pre-test	47.29 (10.70)
Post-test	51.83 (10.16)
Average change	+4.54

^(b) Mean pre-post PIPS standardised scores of general attainment for pupils in age range of sample=50, max=100, min=0.

Table 2: Pre-post intervention observational data from study classrooms n=130

	Child was working on their own	Child was talking with (or listening to) the teacher	Child was engaged with another child in same group or in close proximity in an ordinary lesson	Child was talking with another child in a different group or further away from them in an ordinary lesson	Child suggested an idea or course of action (whether low or high level), or otherwise made some form of statement that someone else could have disagreed with	Child explicitly disagreed with a suggestion or explanation offered by another	Child offered an explanation to a proposition	Child referenced back to another child (child explicitly referred back to a previous suggestion or explanation, irrespective of originator)	Child suggested a resolution or compromise to a situation (child acknowledged previous statement of other and adjusts own to include content and there was an explicit fusion of ideas).	Child told somebody to say something or carry out an action	Child asked an open-ended question that directed attention to something that had not previously been considered
Pre-intervention observation	0.57 (1.44)	0.56 (1.08)	6.78 (1.77)	0.3 (1.03)	2.2 (1.90)	0.46 (0.80)	0.87 (1.12)	0.07 (0.34)	0.01 (0.08)	0.06 (0.91)	0.08 (0.32)
Post-intervention observation	0.45 (1.37)	0.40 (0.68)	6.99 (1.78)	0.18 (0.45)	2.95 (2.47)	0.48 (0.72)	1.13 (1.47)	0.10 (0.29)	0.03 (0.17)	1.13 (1.27)	0.07 (0.26)
Change	-0.12	-0.14	+0.21	-0.12	+0.75	+0.02	+0.26	+0.03	+0.02	+1.07	-0.01

Table 3: The evaluation of the quality and impact of CPD by teachers (n=24)

	Teacher evaluation of training	Teacher evaluation of materials	Teacher evaluation of classroom impact	Teacher evaluation of impact on children's learning
Number of items	4	4	3	7
Maximum possible score	16	16	12	28
Average score (standard deviation)	13.77 (2.00)	14.76 (1.49)	10.36 (1.39)	24.63 (2.70)

Table 4: Coding and themes of teachers' comments from CPD questionnaire

Category	Issue	Number of comments coded
CPD Programme	Welcoming of opportunities to network with other teachers	21
	Welcoming of opportunities to share issues and solutions with other teachers	20
	The support and exemplification of science teaching provided by the CPD was good	13
	The venue for the CPD was too cold	1
Quality of Materials	The materials provided a good structure that illustrated progression and coherence	21
	The materials were written with clarity	13
	It was difficult to find resources to carry out the suggested activities	1
	Lack of differentiation in materials was a problem	1
Management & Implementation of Project	Good support was provided from research staff	12
	There was pressure of time to complete suggested activities	10
	More feedback on results would be desirable	5
Impact upon Professional Practice	The CPD had a positive impact on managing group work	23
	The CPD had a positive impact on confidence to teach science	15
	The CPD had a positive impact on pedagogic knowledge	13
	The CPD had a positive impact on science knowledge and understanding	12
Impact upon children	As a result of the implementing the project there was increased confidence in children	12
	As a result of the implementing the project there was increased self-esteem in children	12
	As a result of the implementing the project there was increased science knowledge and understanding, and skills in children	12
	As a result of the implementing the project there was increased social skills in children	11
	As a result of the implementing the project there was increased social inclusion within the class	8
	It was difficult to include isolated pupils	4
	The assessment load too high	4