Cultural Studies of Science Education

Volume 1

Series Editors

KENNETH TOBIN, *City University of New York*
CATHERINE MILNE, *New York University*

The series is unique in focusing on the publication of scholarly works that employ social and cultural perspectives as foundations for research and other scholarly activities in the three fields implied in its title: science education, education, and social studies of science.

The aim of the series is to establish bridges to related fields, such as those concerned with the social studies of science, public understanding of science, science/technology and human values, or science and literacy. Cultural Studies of Science Education, the book series explicitly aims at establishing such bridges and at building new communities at the interface of currently distinct discourses. In this way, the current almost exclusive focus on science education on school learning would be expanded becoming instead a focus on science education as a cultural, cross-age, cross-class, and cross-disciplinary phenomenon.

The book series is conceived as a parallel to the journal Cultural Studies of Science Education, opening up avenues for publishing works that do not fit into the limited amount of space and topics that can be covered within the same text.

For other titles published in this series, go to
www.springer.com/series/8286

Colette Murphy · Kathryn Scantlebury

Coteaching in International Contexts

Research and Practice

Springer

Editors
Colette Murphy
Queen's University
Belfast
UK
c.a.murphy@qub.ac.uk

Kathryn Scantlebury
Department of Chemistry and Biochemistry
University of Delaware
Newark DE 19716
USA
kscantle@udel.edu

ISBN 978-90-481-3706-0 e-ISBN 978-90-481-3707-7
DOI 10.1007/978-90-481-3707-7
Springer Dordrecht Heidelberg London New York

Library of Congress Control Number: 2010924651

© Springer Science+Business Media B.V. 2010
No part of this work may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, microfilming, recording or otherwise, without written permission from the Publisher, with the exception of any material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Contents

Chapter 1
Introduction to Coteaching

Colette Murphy and Kathryn Scantlebury

Coteaching is two or more teachers teaching together, sharing responsibility for meeting the learning needs of students and, at the same time, learning from each other. Coteachers plan, teach and evaluate lessons together, working as collaborators on every aspect of instruction. Over the past decade, coteaching has become an increasingly important element of science teacher education and it is expanding into other content areas and educational settings as a result of research, which has shown that it can be highly beneficial to both students and teachers. Indeed, two chapter authors of this volume (Karen Kerr and Matthew Juck) acted as student teacher coteachers during their preservice teacher education programmes. Kerr, from Northern Ireland, taught for 2 years and then completed her Ph.D. in primary science education. She is now working as a postdoctoral research fellow on coteaching. Juck, from Delaware, is now a cooperating coteacher, where he supports the next generation of science teachers. Martin (2009) discusses coteaching in the United States that is focused on learning to teach science. She provides a historical background for the evolvement of coteaching in the United States, noting that initial practices included team teaching, in which teachers provided instruction, typically through lectures, for large groups of students and then divided in smaller groups for further work. Coteaching then became a framework for special education instruction and included various teaching arrangements and roles including (1) one teacher instructing, the other observing; (2) having stations around the class; (3) parallel teaching, in which the teachers would divide the class and teach two groups of students; (4) team teaching in which one teacher assumed responsibility for a section of the curriculum and did the classroom instruction and assessment; (5) alternate teaching, in which teachers assumed single responsibility for instruction on a particular topic within a lesson; (6) one teacher assuming teaching responsibility and the other monitoring students, helping where needed; and (7) complementary teaching (Martin 2009).

These approaches had a common characteristic in that teachers did not share all the responsibilities for all students' learning throughout an instructional time frame (e.g. a class) or curricular unit. In some cases, special education teachers taught only those students designated as special needs. Often, special education teachers

C. Murphy and K. Scantlebury (eds.), *Coteaching in International Contexts: Research and Practice*, Cultural Studies of Science Education,
DOI 10.1007/978-90-481-3707-7_1, © Springer Science+Business Media B.V. 2010

did not engage in curriculum planning and assessment for the course, but rather they reviewed and revised the instruction planned for the general students and adapted it to take account of their students' needs. However, a more inclusive model of coteaching between content teachers and special education teachers is possible (Gleason et al. 2006).

Coteaching in science education began as a model for learning *how to teach*. But, it has also evolved to be a model *for* teaching (Martin 2009). With regard to learning *how to teach*, preservice elementary teachers have cotaught with one another in university methods the courses that focused on inquiry (Eick and Dias 2005) or pedagogy (Eick and Ware 2005). In other settings, coteaching provides additional human resources in the form of science-specialist preservice teachers who coteach with the cooperating teachers; the aims are to enhance science learning for children, science teaching for cooperating teachers and the development of teaching skills of preservice teachers as they worked hand in hand with the cooperating teachers (Murphy and Beggs 2005).

Although student teaching is a common characteristic of most teacher education programmes, there have been few changes in the format and structure of the experience nor is there much variation in its implementation across education levels, universities and/or countries. Typically, a preservice teacher who is towards the end of his/her formal teacher education programme is placed with an experienced teacher who acts as a mentor during the student teaching experience. Student teaching is akin to an apprenticeship, the novice teacher learning from the experienced teacher and through the 'on-the-job' training approach. In this model, vin a subservient position to a cooperating teacher, although the student teacher may have more recent knowledge of the field both in content and pedagogy, that is, the student teacher's science content knowledge and his/her perspectives on learning theories, assessment practices and curriculum may be more current than the cooperating teacher. This edited book illustrates how coteaching between student teachers and cooperating teachers has enhanced the school placement experience for all participants in preservice teacher education programmes in many parts of the world.

The book explores coteaching in a wide variety of contexts. The studies span three continents: Europe, America and Australia, primary, secondary and tertiary science education. They evaluate coteaching between preservice and cooperating teachers, between teacher educators and teachers, parents and teachers, students, teachers and special instructors such as translators or inclusion teachers, teacher educators and preservice teachers and between teacher educators.

The studies differ in scale from the large-scale implementation of coteaching to in-depth ethnographic approaches within single schools or classes. The coteaching studies in this book have utilized the concept as a model for initial teacher education, for teachers' professional development, to enhance the learning experience for students and to expand the role of parents as coteachers in schools.

Coteaching has been implemented as a way to address a variety of issues in science education. For example:

- Preservice and cooperating teacher anxiety with regard to science teaching (most commonly felt by elementary teachers and those secondary teachers who are teaching outside their main science discipline)
- Preservice teacher anxiety during field and student teaching experiences
- The gap between theory and practice experienced by preservice and cooperating teachers
- Ineffective student learning as a consequence of inadequate preservice teacher practice
- Student disaffection
- Declining student attitudes towards school science
- Parental involvement in classrooms
- Mainstreaming students with special needs

Coteaching provides a structure for teacher reflection on theory, praxis and practice. The chapter authors have used several different theoretical lenses to explore coteaching and its impact on science classrooms and learners. In this book, the theoretical frameworks span sociocultural, social development and neo-Vygotskian learning theories. In recent years the influence of cultural psychology on research in science education (e.g., the work of Vygotsky and Luria) has foregrounded the importance of external and cultural influences on learning. This perspective differs from those that focused on internal influences and student-centred approaches to learning (e.g., Piaget and Gardner) and assumes that learning is situated in social contexts. The chapters illustrate that there is no 'one theory' or 'one model' of coteaching, any more than there is a single theory of teaching. However, there are commonalities that can be drawn from across the diverse coteaching contexts. All studies show that coteaching expands teacher agency, and also student agency when cogenerative dialogues are incorporated into coteaching, thus improving confidence and performance for teachers and students. In addition, studies show that teachers focus more on student learning when they are coteaching, partly due to cogenerative dialogues as a format for teachers, students and/or other classroom participants' joint reflections on cotaught lessons.

1.1 Structure of the Book

This book brings together 10 years' work on the research and practice of coteaching and its impact on teaching and learning, predominantly in the sciences. It includes contributions from Europe, United States and Australia and presents an overview of theory and practice common to most studies. As such, a feature of this book is that each chapter has different styles, corresponding to the context in which the work is set. The book has four sections: (1) large-scale studies of coteaching; (2) theory into practice; (3) coteaching contexts; and (4) use of cogenerative dialogues. Coteaching recognizes that preservice teachers, and K-12 students, have

knowledge and perspectives on practices that may engage students' learning. In this book, the model of coteaching has expanded from preservice teachers with experienced teachers, to include students involved in the classes from middle through college and other stake holders such as parents.

The first section describes two large-scale studies of coteaching in primary and elementary schools, which have taken place on opposite sides of the Atlantic. These studies look at the impact of coteaching on the children, as well on the preservice and cooperating teachers. They provide evidence of a positive impact of coteaching on children's attitudes and learning and address the interests of stakeholders in the question of whether coteaching 'works'. Murphy and Beggs review their ongoing research on science coteaching in more than 120 schools in Northern Ireland. Most of the work was carried out in primary schools (age 4–11) whilst more recent studies have incorporated coteaching in science classes for 11–14-year-old children in secondary schools. They describe their model of coteaching and provide evidence of significant enhancement of children's attitudes to science learning when comparing children from cotaught with those from non-cotaught classes. In addition, cooperating teachers gained in confidence and enjoyment when teaching science and preservice teachers reported increased confidence teaching all subject areas. Murphy and Beggs' chapter discusses how coteaching expands the agency of all participants and promotes more democratic classrooms. Bacharah, Washut, Heck and Dahlberg's chapter focuses on the academic achievement of K-6 students who were members of classes, which were cotaught by cooperating and student teachers in Minnesota. Children in cotaught classes attained significantly improved achievement scores in reading and mathematics compared to their peers in non-cotaught classes. These results have important implications for policy because those two subjects are the basis for the US government's No Child Left Behind legislature that mandates district and school accountability for student achievement in reading and mathematics.

The second section focuses on how sociocultural theories explain various issues in different coteaching contexts. Siry and Martin's chapter, written with their students, Shelley Baker, Nicole Lowell, Jenna Marvin and Yushaneen Wilson, expands the characteristics of coteaching from cooperating teacher and student teachers, to professors coteaching with their students (who are K-12 teachers). What evolves in this chapter is how university professors can re-think course structures to share the teaching responsibility among all stakeholders. By using coteaching and cogenerative dialogues in teacher education courses, Siry et al. have expanded the possibilities of how these two pedagogical tools can be used and implemented in education. Tobin and Llena's chapter examines how cogenerative dialogues are used to enact cultural production and provide students the opportunity to learn science through their agency and passivity.

The third section provides a range of different coteaching contexts that emphasise the versatility of the approach. Several of the studies examine coteaching between preservice and cooperating teachers. Gallo-Fox's chapter reports on how coteaching enabled teachers to engage in risk-taking pedagogical practices. Yet the risks teachers took were different for cooperating teachers and interns. Carlisle's

chapter focuses on the progression of coteaching practices between preservice and cooperating teachers as the placements continued. Initially, preservice teachers observed in the classroom but their practice evolved to a co-sharing of the teaching responsibility and a diverse range of roles as they gained more experience and confidence. Kerr's chapter reports on how student and cooperating teachers undertook shared learning via a continuing professional development programme focused on creative science teaching prior to embarking on coteaching in school. Their coteaching centred on implementation of the creative science teaching approaches in the classroom. This model, in which coteachers both learned and taught together, has provided some of the best evidence of sustainable professional development for teachers. O'Conaill's chapter describes the implementation of coteaching to create partnerships between final year preservice teachers and cooperating teachers, which acknowledged the cooperating teachers' expertise and their willingess to work with preservice teachers. Neither of these features are common to most Irish teacher education programmes – there is no formal mentoring role for the cooperating teacher. Assessment of preservice teachers is carried out by the university teacher educators. Coteaching, in this case as a subject-specific collaboration, provides teachers with the opportunity to counter the increasing dominance of performativity discourse in primary education as the purpose and outcome of each lesson is publicly negotiated. This contributes to ownership of the teaching process and as opposed to an agenda of delivery and deliverance, enables risk-taking, responsive teaching beneficial to all as teachers and learners.

Two chapters in this section explore the teaching of science through the use of coteaching between a university science professor and a teacher. Carambo's chapter shows a different context for coteaching between teachers and content professors: how K-12 teachers with many years of pedagogical experience can expand the learning opportunities in a class that is focused on improving teachers' content knowledge. Nilsson's focus is on how a physics professor collaborates with a primary school teacher to coteach a physics course for preservice primary school teachers in Sweden.

A further two chapters consider coteaching between schoolteachers. Juck, Scantlebury and Gallo-Fox's study follows three science teachers who experienced coteaching as the structure for student teaching into their first year as 'solo' teachers. While they faced similar challenges to many first year teachers, all three examined their changed teaching structures to prioritize collaborative relationships with peers, mentors or colleagues at other schools. The strength of coteaching as a structure for teaching students is illustrated in Upadhyay and Gifford's study of teaching science to Hmong students in Minneapolis. For these students whose culture is very different from their teacher's, the result of having a coteaching arrangement where one teacher better understands science and the other the students' culture was a more positive learning experience in which the students began to appreciate the importance of science in their lives.

Moving into yet another context, Willis and Ritchie explore how parents became involved in coteaching and cogenerative dialogues in a primary school classroom in Australia. The teacher and parent used email as a structure to co-plan lessons

when direct contact was not possible. Willis and Ritchie conclude that there may be considerable merit in parents positioning themselves, where appropriate, in new spaces for meaningful school engagement.

The fourth and final section foregrounds the use of cogenerative dialogues. Cogenerative dialogues (cogens) are a critical facet of many coteaching arrangements. The purpose of cogens is for a group of stakeholders to discuss the teaching and learning that is occurring in an education setting. The structure of cogens is such that no one person's voice is privileged and participants generate local theory and knowledge focused on the teaching and learning of science or math. Cogens enable coteachers to examine their teaching practices, and when cogens include other stakeholders such as students, strategies to improve teaching and learning are often co-generated. This section discusses the various ways cogens and coteaching are implemented in schools, specifically urban schools. In the United States, one third of the K-12 population attends urban schools. Research has documented the challenging issues that impact teachers and students in these settings from poorly resourced classrooms to disenfranchised students (Bayne 2009). Grimes' study is located in a private New York City school and she engaged three tenth grade girls in coteaching a sixth grade science class. Grimes used cogens with her tenth grade students to develop and reflect upon the coteaching that she and the girls completed in the sixth grade science class. Jackson, Wharton, Pitts and Woodburn have expanded the use of coteaching and cogens from science into mathematics classes. Jackson also used students as coteachers in his seventh grade mathematics class. Two girls, Cece and Bebe, used their cultural knowledge to improve their mathematical knowledge through coteaching math. Wharton and Pitts' study focused on a different group of math students, that is, adults seeking a high school diploma. In their study of cogens in a GED (Grade Equivalent Degree) with maths, illustrate how cogens can also produce coteaching situations between students, and the teachers and students. By re-structuring her class using cogens and coteaching, Woodburn engaged students in learning mathematics who had previously failed in the subject and had low self-esteem, lack of respect (for self and others) and negative attitude towards mathematics and schooling. Their study group comprised the teacher (Woodburn) and 13 students from diverse cultural backgrounds. Through the use of cogens, the group established teams of coteachers, four people in each group to teach one lesson per week. The opportunity to engage in learning math through a different structure led to improved student achievement and attitudes.

In the epilogue, Scantlebury and Murphy draw together the cogent features of the 10 years' work on coteaching. They consider critiques of coteaching and point the way forward for the development and wider implementation of coteaching as an approach to improving learning and teaching in classrooms in many contexts. The coteaching approach can be applied globally and, at the same time, has its roots in the most local contexts as a way of engaging coteachers and their students in a more democratic, open and effective learning environment. Finally, they consider how the use of coteaching and cogenerative dialogue is key in implementing major policy developments, particularly those in the UK and the United States.

References

Bayne, G. (2009). Cogenerative dialogues: The creation of interstitial culture in the New York metroplis. In W.-M. Roth & K. Tobin (Eds.), *World of science education: North America* (pp. 513–527). The Netherlands: Sense Publishers.

Eick, C. J. & Dias, M. (2005). Building the authority of experience in communities of practice: The development of preservice teachers' practical knowledge through coteaching in inquiry classrooms. *Science Education, 89*, 470–491.

Eick, C. J. & Ware, F. (2005). Coteaching in a science methods course: An apprenticeship model for early induction to the secondary classroom. In W.-M. Roth & K. Tobin (Eds.), *Teaching together, learning together* (pp. 187–286). New York: Peter Lang.

Gleason, S., Fennemore, M., & Scantlebury, K. (2006). Choreographing teaching: Coteaching with special education/inclusion teachers in science classrooms. In K. Tobin (Ed.), *Teaching and learning science: A handbook* (pp. 235–238). New York: Praeger.

Martin, S. (2009). Learning to teach science. In K. Tobin & W.-M. Roth (Eds.), *World of science education: North America* (pp. 567–586). The Netherlands: Sense Publishers.

Murphy, C. & Beggs, J. (2005). Coteaching as an approach to enhance science learning and teaching in primary schools. In W.-M. Roth & K. Tobin (Eds.), *Teaching together, learning together* (pp. 207–231). New York: Peter Lang.

Part I
Large-Scale Studies of Coteaching

The two large-scale studies in this section describe the process and impact of coteaching in several 100 schools in Europe and North America. The first discusses how the coteaching of science between classroom teachers and student teachers (who were science specialists) facilitated the expansion of agency in all participants by promoting greater sharing of ownership of learning in the classroom. Classrooms became more democratic and power shifted from one to many. This chapter outlines the benefits of coteaching accrued by classroom teachers, student teachers, and children. It also considers how participants prepare for successful coteaching. It identifies patterns in terms of ways that coteaching is enacted and evaluates the impact of coteaching among participants. Some of the major benefits of coteaching primary science include increased confidence and enjoyment of primary school teachers in learning with and teaching science to children, increased confidence and higher performance on assessed, non-cotaught ("solo") teaching placements in student teachers who had cotaught science with classroom teachers, and improved enjoyment and interest in learning school science by children. Children's attitudes to school science learning were measured 6 months after coteaching ended to determine whether there was lasting impact of science teaching by classroom teachers who had cotaught with science specialist student teachers; attitudes to school science were significantly more positive in children from cotaught classes than those from non-cotaught classes.

The second chapter in this section describes a coteaching program at St. Cloud State University, which began as a partnership with one local school district, serving approximately 10,000 students in grades PreK-12 and quickly expanded to include formal partnerships with 17 local school districts and provides training and support in coteaching to any interested teacher outside the partner districts. In this work, the impact of coteaching on K-6 learner outcomes was examined. Two assessment instruments that focused on the reading and math skills of cotaught students versus non-cotaught students were used. Students in cotaught classrooms had better academic outcomes in reading and math than their peers in non-cotaught settings. Students demonstrated academic gains in both areas at a statistically significant level during all 4 years. When the reading and math achievement scores were compared between students in classrooms where teacher candidates cotaught with their

cooperating teacher and those in classrooms where the teacher candidates utilized a traditional student-teaching model, the students in cotaught classrooms demonstrated significantly higher gains than those from non-cotaught classrooms. In addition to analyzing academic achievement data, students in grades K-12 were interviewed in focus groups and overwhelmingly identified getting help when they needed it as the number one benefit of coteaching. They also highlighted a greater variety of activities, more than one teaching style, decreased behavioral problems, and increased feelings of connectedness to school as advantages of coteaching. As with the previous chapter, both teacher candidates and cooperating teachers reported significant benefits of coteaching in terms of teaching enjoyment and performance.

Chapter 2
A Five-Year Systematic Study of Coteaching Science in 120 Primary Schools

Colette Murphy and Jim Beggs

2.1 Introduction

This chapter explores ways in which coteaching can be used to address theoretical and practical problems in contemporary pre-service teacher education. Many aspects of school education have changed over the last 50 years, particularly in relation to learner characteristics, increasing levels of government regulation and bureaucracy, globalisation and political uncertainty. Pre-service teacher education has not, in the main, embraced these changes, and consequently, new teachers lack the agency and confidence required for effective engagement with students. Coteaching provides a new way of 'mentoring' that assumes that the student teacher is not a blank slate, but someone who has different, yet valuable expertise, which can be shared with the classroom teacher to enhance the learning of the children. Coteaching science in primary schools, for example, enables the student teacher to bring scientific expertise to the classroom, which can be shared with the pedagogical expertise of the classroom teacher to improve children's interest, enjoyment and learning of science. Coteaching, therefore, can expand the agency of student teachers in the classroom and improve the confidence of primary school teachers to teach science.

We describe our work in preparing for and implementing coteaching. In Northern Ireland, approximately 120 primary schools have been involved in coteaching since we started this work in 2002. We present and discuss data relating to the student teachers', classroom teachers', children's and university teacher educators' experiences of coteaching and the effect on primary science learning and teaching. We also show how we have used coteaching to enhance teachers' and student teachers' information and communication technology (ICT) skills, specifically their use of virtual learning environments (VLEs) and computer-mediated technologies. Finally, we have expanded our use of coteaching to improve the sustainability of teachers' continuing professional development (CPD) work by their sharing both the learning programmes and their implementation in the classroom via coteaching with pre-service student teachers. This is described in Karen Kerr's chapter later in the book.

C. Murphy and K. Scantlebury (eds.), *Coteaching in International Contexts: Research and Practice*, Cultural Studies of Science Education,
DOI 10.1007/978-90-481-3707-7_2, © Springer Science+Business Media B.V. 2010

2.2 Model of Coteaching

Coteaching explicitly brings two or more teachers together to improve what they can offer to the children they teach, while providing them opportunities to learn more about their own teaching. It involves the shared planning, teaching and evaluation of lessons. Each coteacher can learn from the other without even attempting to do so. In our model of coteaching, the student teachers and the classroom teachers act as *equals*, each bringing specific expertise to the lesson (Fig. 2.1).

We used coteaching as a way to expand the agency of student teachers in the classroom. Our concept of agency can be described as the power of the student teacher to access appropriate resources in the classroom. We felt that via coteaching, they could access the greatest resource available to them: an experienced classroom teacher. Lavoie and Roth (2001) observed that student teachers rarely (if ever) get to work alongside an experienced teacher – they normally observe someone teaching or teach alone. The student teachers are science specialists; science makes up one third of their bachelor of education degree. By the time they start coteaching (year 3 of a 4-year degree), they have a good knowledge of science and science pedagogy, but their experience of elementary teaching (all subjects) will have totalled only 16 weeks. The classroom teachers, on the other hand, are well experienced in elementary teaching, but many lack both the background science knowledge and the confidence to teach science. By coteaching with a student teacher who has a very good knowledge of science and science pedagogy, the classroom teachers might develop their own confidence in science teaching.

There is much research evidence highlighting the lack of confidence among elementary teachers to teach science. In the USA, there has been a lot of concern about the standard of preparation of science and mathematics teachers (Barufaldi and Reinhartz 2001). During the 1980s and 1990s, more than 500 national reports

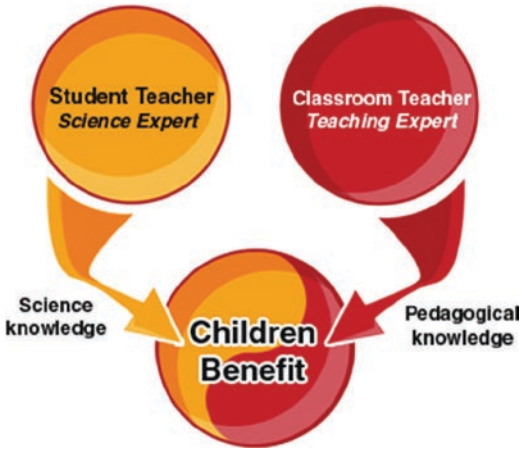

Fig. 2.1 Model of coteaching for primary science

addressed various inadequacies in science curricula and in the preparation of new teachers. Many of the resultant reforms centred on collaborative efforts to effect change. In the UK, Harlen, Holroyd, and Byrne (1995) found that many primary teachers lacked confidence in their ability to teach science and technology. A third of these teachers identified their own lack of background knowledge as a source of their problems. More recently, Murphy and Beggs (2005a, b) carried out a large-scale study to explore teachers' views and experiences of primary science education across the UK and to identify ways in which it could be improved. They reported that a high proportion of primary teachers felt they lacked the confidence, expertise and training to teach current science curricula effectively.

Our coteaching projects were set up to improve children's experience and learning of science by addressing the issues of primary teachers' lack of confidence in science teaching and student teachers' lack of agency in the classroom.

2.3 Implementation of a Coteaching Model

Implementation of coteaching is discussed in three sections: preparation, enactment and evaluation.

Preparation for Coteaching

We developed the idea of student teachers working in the classroom with experienced teachers in a way that would ensure the sharing of expertise. The idea originated in discussions between university teacher educators and school principals.

The guiding principle in setting up coteaching was to avoid participants 'stepping on each other's toes'. From the outset the university teacher educators planned to actively include all participants in the coteaching research design and to ensure that each was willing to accept the responsibilities associated with working in new ways in the classroom. It was stressed that coteachers would concentrate on enhancing the children's learning experience of school science. We also promoted communication channels that enabled individuals to voice concerns about issues they felt uncomfortable discussing with their coteachers. In addition, and in response to advice from the school principals who were involved in the original research design, we organised workshops for classroom teachers to develop further their knowledge and skills in science teaching, so they would feel better equipped when working with the student teachers. These sessions ran before, during and after the coteaching placements and provided the university teacher educators with valuable feedback from the class teachers in relation to their experiences of coteaching. The student teachers provided similar feedback during science classes at the University College.

Initially, we (university teacher educators) set up a meeting with the principals of the first ten participating schools. The meeting was intentionally held on neutral ground, at a conference hotel, and explored issues relating to coteaching with the intention of refining the research and implementation design. The principals questioned us about the respective roles of student and classroom teachers in the classroom.

A collective decision was reached that project participants would develop codes of practice for classroom teachers, student teachers and university teacher educators. Principals were also concerned that some teachers might be anxious about how to coteach. We were unable to provide a how-to guide; instead, a second collective decision was made that coteaching teams would discuss a range of possible coteaching scenarios. The value of this preparatory work with school principals was immense. School principals were much more aware than we were of possible constraints. They appreciated the need for great care in our approach during all steps of implementation. They accepted responsibility for their role in the project which, we felt, was crucial. In retrospect, their advice and intimate knowledge of the work was key to the reported successes (Murphy et al. 2004b).

The next stage was a 1-day launch seminar, attended by school principals and all coteachers: classroom teachers, student teachers and university teacher educators. The seminar aimed at enabling coteachers to get to know each other and to work together in ways which would lead to developing successful working relationships. Coteaching teams developed codes of practice by adapting codes previously created for teachers and student teachers during 'non-coteaching' school placements. They also discussed the strategies they may adopt in hypothetical coteaching situations, such as the following:

For each scenario, consider your strategies for (a) that day and (b) future planning:

1. The class teacher and student teacher have planned a science investigation to take place during week 2 of the placement. The class teacher is absent on that day – the student teacher arrives and a substitute teacher is in class.
2. The class teacher and student teacher have planned a science investigation to take place during week 2 of the placement. The student teacher phones in sick on that day.
3. After a week or 2 you feel that all is not well in your relationship with the class teacher/student teacher.

Other group activities included adapting a reflective diary for use by coteachers, discussions relating to anxieties surrounding coteaching and suggestions for improving the research design. This day was intensive and intentionally provocative so that participants appreciated their responsibilities in the project. Participants were asked to consider seriously their involvement in the project and those who were still willing signed a code of practice. There was to be no penalty for those who felt unable to sign; alternative arrangements for non-coteaching placements would be made. All participants signed up. Their evaluations of the day recognised the importance of their role in the design and implementation of coteaching. Most were really looking forward to the project and a few were also still anxious about their role. This anxiety partly arose as a result of our inability to inform coteachers about how to coteach. We had never tried this before. The project was innovative and we were hoping that the participants would apprise us as to how coteaching could be successfully enacted in the classroom.

Typical comments from the student teachers, recorded in the reflective diaries indicated a mixture of their enthusiasm for science teaching, the value of learning

from working together with experienced teachers, and some anxiety about their role as coteachers, for instance:

> I like the format that the project offers. I feel that it will give a certain degree of freedom to try new ideas and experiment with ways of teaching that will allow me to inject a more practical element back into science.
>
> I am to use my knowledge to provide investigative and practical ideas to create a fun, discovery-learning, science environment in which children are stimulated to learning. To gain an understanding of children's thoughts, opinions, ideas of what science is and their understanding of scientific concepts.
>
> I expect this experience to be very beneficial for me as it will enable me to spend more time in the classroom working with children from varying backgrounds teaching a subject I enjoy and hopefully passing my enthusiasm onto the children
>
> I will gain an insight into the teaching of science in the primary classroom. I hope to learn different skills from the teacher and become more confident in the teaching of science.
>
> I will learn about children's and teacher's views of science. Learn how a teacher goes about teaching science in the primary school, experience the management of a science lesson and experience the many safety aspects considered in a science lesson.
>
> I'm a bit confused about my role in the classroom during this project. I understand the concept of team teaching but I'm not exactly sure how I will fit into this role. I feel I might be stepping on the teacher's toes if I interrupt her lesson questioning. On the other hand I don't want to feel like a spare part in this role of team teaching. I want to participate fully.
>
> I hope it develops well and I'm very interested in how the team teaching will progress. I am also keen to teach science from an alternative perspective that I have been used to.

In the first year of our work, we referred to the innovation as team teaching, until we read about *coteaching* which more accurately reflected what we were trying to do.

The classroom teachers' comments about what they expected from coteaching were different in that they reflected the teachers' intention to support the student teachers in the classroom and the hope that they would learn more about their own science teaching, for example:

> To give the student teacher the opportunity to grow in experience and help me to plan and deliver a science topic.
>
> To give students valuable opportunities to develop teaching skills in the class situation.
>
> To see science being taught by a specialist who can bring a different light into experiment and practical work for the children.
>
> To gain further understanding of the subject area and confidence in tackling activities previously not taught by using student's expertise.

We were keen to address issues of social capital and agency in this work. According to Putnam (1993) social capital refers to features of social organisation such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit. We tried to ensure that our implementation of coteaching facilitated social capital and focused many of our efforts on building trust and openness. We also discussed changing power relationships with the coteachers: they were going to work in a non-traditional way in the classroom.

The student teachers would have more agency in the classroom and would expand the opportunities now open to them. Classroom teachers would develop more agency in regard to science teaching: they would have improved access to scientific resources and their use with children by working alongside the science specialist student teachers. However, the classroom teacher would have less power in that they would be sharing access to children and the classroom. Children in the classroom would have much more agency in that they would have improved access to their teachers and would be given more time and resources to develop scientific thought and processes. University teacher educators would get more opportunity to work with children, student teachers and classroom teachers, thus giving them more agency, both in the classroom and in practicing what they preach. However, they would also lose power over the student teachers and, to some extent, the classroom teachers. In the coteaching situation they would be expected to work alongside their new peers and, potentially, expose some of their inadequacy in the classroom situation.

We promoted discussion of these issues during the launch seminar. The following quote from a school principal reiterated the importance of sharing ownership of the research design with the classroom teachers:

> I thought the launch day was very good in the [hotel name] and I thought the working in small groups was very good, people discussing their priorities and groups of teachers putting in what they saw – because sometimes it can be very management directed. But the input of the teachers was very good because when they have input then they will want to follow it through…

Enactment of Coteaching

It is difficult to enact *equal* responsibility in coteaching. Having equal responsibility does *not* mean that coteachers are doing the same thing at the same time; it does not even require that coteachers are teaching together. Our working definition was that coteachers shared responsibility for the children's enjoyment and learning of science. After the first year, we identified the most common enactments of coteaching. In some classes, all were evident. These were: equal teaching roles for student and classroom teachers; one leading under the guidance of another; one leading and the other acting as 'assistant' and one leading as the other observes, all coteachers working with small groups of children and children themselves acting as coteachers. These models are all illustrated by video clips and can be viewed online in a continuing professional development unit on coteaching (Murphy and Beggs 2006).

2.3.1 Equal Teaching Roles

Figure 2.2 illustrates equal teaching roles in the lesson. The student teacher (on the left) and the classroom teacher are teaching together to maximise the learning opportunities for the children. In this lesson, the coteachers were discussing the senses and then asking the children to sort toys into groups using their senses of sight and touch.

Fig. 2.2 Equal coteaching roles

2.3.2 Student Teacher Leads; Classroom Teacher Guides

One of the main benefits of coteaching for student teachers is to develop more confidence in their teaching whilst working side by side with a more experienced classroom teacher. This was evident from video footage of some of the cotaught lessons; the student teacher frequently turned around and checked whether what she/he was saying was appropriate whilst leading a lesson. In one specific instance the student teacher was leading the introductory discussion to a 'dissolving' activity. She was asking children for their ideas of different common substances which dissolve. One of the children answered 'Disprol' – the brand name of a pain reliever. The student teacher said 'yes' and then quietly asked the teacher about whether this type of answer was acceptable. The classroom teacher assented and the children then came up with lots of good examples of substances which dissolved, often using brand names.

2.3.3 Classroom Teacher Leads: Student Teacher Guides

In respect of running science investigations, the student teachers, being science specialists, offered advice during the lesson when the classroom teacher was leading. This can be illustrated in the following lesson transcript. The lesson is the same one described in the previous paragraph. The classroom teacher is leading an investigation into dissolving; the student teacher helps the teacher to promote the development of children's scientific skills.

> Classroom teacher: Pour it [sand] in very carefully and don't put the water in until you are told.

Student teacher: Should we get them to predict what is going to happen?

Classroom teacher: Girls, will you think about what might happen, what do you think is going to happen?

2.3.4 Student Teacher Leads: Teacher Assists

In some lessons or parts of lessons, the coteaching model comprised the student teacher leading the lesson whilst the classroom teacher acted as an 'assistant', supporting the work of the student. For instance, I observed a student teacher using a pupil-assisted demonstration to help illustrate the concepts of transparency and opacity. During the demonstration the classroom teacher assisted by passing particular materials to children or to the student teacher.

2.3.5 Classroom Teacher Leads; Student Assists

In this model the classroom teacher might be leading a science investigation in which the student teacher's role is 'another pair of hands'. The classroom teacher would direct the work of the student teacher. We observed this situation in a lesson in which the children were designing air-propelled 'cars'. The classroom teacher was taking the children through the different elements of design; the student teacher's role in this case was to ensure each child had access to the different materials they required.

2.3.6 Student Teacher and Classroom Teacher Each Work with Small Groups

This coteaching model was evident at certain stages in almost all observed classes. Each coteacher assisted small groups of children during the practical activity. It was during this stage of the lesson that visiting university teacher educators and/or researchers would most commonly act as coteachers unless asked to play a different role by the other coteachers in the room. The opportunity to interact with children during the science lessons was highly valued by the university teacher educators; many had not 'taught' young children for years.

2.3.7 Student Teacher Leads: Classroom Teacher Observes and Vice Versa

On occasions during coteaching, one coteacher might be interested in receiving feedback on their teaching. In this case, one coteacher might be observing a lesson. Our experience of this model showed that the opportunity to observe as an equal

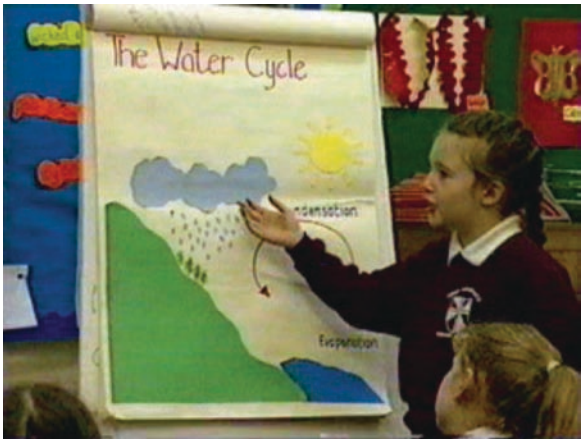

Fig. 2.3 Child as coteacher

promoted much self-reflection. In the following extract from an interview, a classroom teacher is reflecting on her own practice as she observes the student teacher.

> One of the main things that I gained was that you could sit back and watch your children responding to somebody teaching them. … You could see that there was sometimes children in the classroom continually getting the attention from the student teacher because they were the loudest who were always coming up with answers, always being funny. They were getting the attention and there were other children who were being completely ignored … because they were quiet and sitting not making a sound but not showing any interest. It made me aware that I'm probably doing that in my teaching. (Classroom teacher)

2.3.8 Child Acts as a Coteacher

When children experience more than one person teaching, it is possible that they might feel more comfortable acting as a coteacher themselves. We strongly encouraged teachers to include this role for children as much as possible. Figure 2.3 illustrates a child leading part of the lesson on the water cycle. The child is guided by the student teacher to explain the water cycle in her own words to the rest of the class.

2.4 Implementation Issues

2.4.1 Should Student Teachers Be Assessed During Coteaching?

Coteaching is a new way of working and can lead to feelings of anxiety in regard to enacting the role as coteacher. We intentionally promoted the idea that coteaching in the classroom would not be assessed. When university teacher educators

visited classrooms, their role was to support the children's learning by adding their expertise and not to supervise the student teachers. There was no debriefing about the teaching performance. Instead, the university tutors were included in the lesson evaluation discussion and invited to share their experiences. These discussions were similar to cogenerative dialogues (Roth and Tobin 2002). They could not be presented as true cogenerative dialogues, however, since they did not include representatives of all groups participating in the lesson; there were no children present.

We were also concerned that obvious mentoring by the classroom teachers might serve to diminish the agency of the student teachers and make the latter feel as though they were being judged, as opposed to acting as an equal participant in the promotion of better science learning and teaching in the classroom. Coteachers were encouraged to share expertise.

2.4.2 Should Coteachers Be 'Matched'?

It was clear from the start that in coteaching we are asking classroom teachers to share that which they were used to doing alone. There are many ethical issues that arise. The preparatory work described above was carried out to raise awareness and anticipate the particular types of issues pertaining to each classroom. After the first year of coteaching it was evident that, in some cases, random pairing of student and classroom teachers was not always ideal. We discussed the possibility of introducing an element of matching for future projects. The participants felt this may be a useful step. The University College co-director of the coteaching projects visited each school principal and they discussed potential coteaching teams which would work best to promote children's enjoyment and learning of science. This careful and sensitive process did lead to more harmonious coteaching and was adopted in all future work.

2.4.3 Promoting Harmonious Coteaching

We investigated ways of promoting harmony between coteachers by analysing their reflections in the coteaching diaries they kept and from interview transcripts. The data from the student teachers revealed that there was most harmony in the relationship between student teachers and teachers when the respective roles were perceived as equal, less harmony when the role of the student teacher was perceived to be dominant, and least harmonious of all when the role of the teacher was perceived to be dominant. This trend is illustrated in Fig. 2.4, which summarises comments from student teacher diaries and interviews.

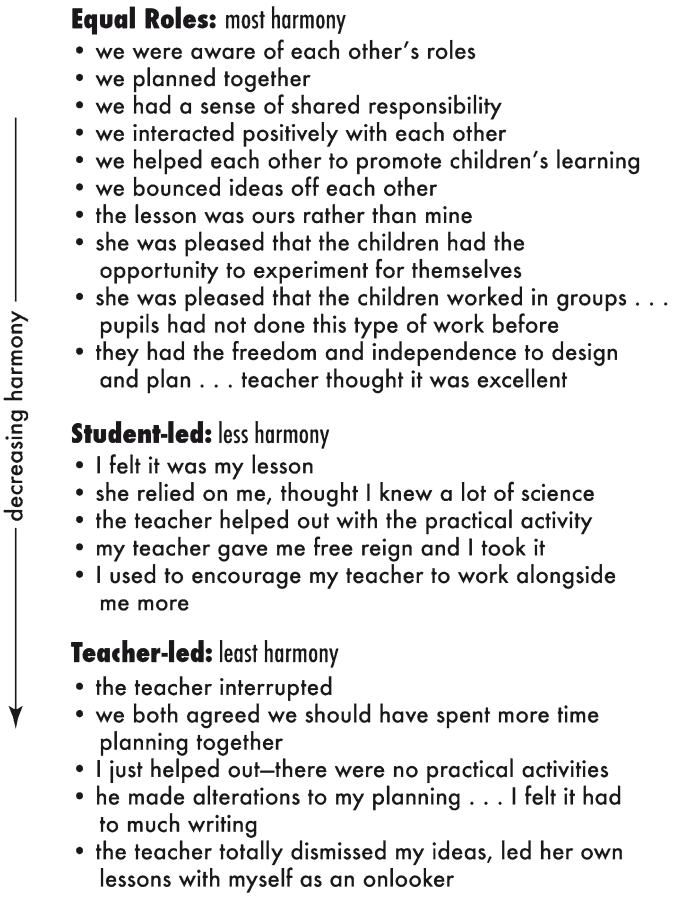

Fig. 2.4 Harmony in coteaching

2.4.4 Anxiety About Coteaching Role

Anxiety about how to coteach is the most challenging aspect for all concerned. The research team acknowledge this and initially invited participants to share their different ways of enacting coteaching for subsequent cohorts. We videoed several cotaught sessions and provided concrete information about ways to coteach. The following extract from a discussion between Jim, project co-director, and Loretta, a school principal, provides some insight to some of the issues surrounding role anxiety:

> Jim: Had you any concerns that affected your decision to take part?
>
> Loretta: I was very interested from the very start. The concerns I had would have been to do with any project. First of all I was concerned about the quality of the student teachers,

how well they would be able to support our teachers and to work alongside them. I was also concerned about the consistency of the program: would people turn up regularly or would there be reasons why the program couldn't run on certain days? That could create a problem in schools in that teachers and children are waiting for someone to come in and if they don't arrive they get very disappointed. That, in turn, affects the whole program. The other concerns I had really were that it was a different relationship to teaching practice and I was wondering how both the teachers and the students would cope with that.

Jim: How were these issues addressed for you before the project started?

Loretta: We had talked about the quality of students and obviously not every student is at exactly the same level and we knew there was going to be a slight variation. Having said that, we were very happy with the quality of support that was provided and in some cases there were students who weren't brilliant at the beginning but with confidence did become much better and contributed a lot to the program. The student teachers were very consistent. They had been here for the whole 10 weeks and I felt that contributed a lot to what the teachers got out of it. They expected it to happen each week and it did happen and they were happy with that. The relationship issue just really wasn't one in the end. They both got on and worked well together and no concerns were brought to me by teachers about that.

Jim: Why did you become involved?

Loretta: First of all, I'm really interested in primary science I think it's a brilliant subject for primary school. It's a cross curricular subject in which children can learn skills in all sorts of areas but also it teaches them a particular way of thinking about things which they don't get in other subjects. That's the main reason why I would be interested in any project of this type. Secondly, I was very interested in a professional development point of view for my teachers and interested in anything that can enhance their skills in the classroom. Thirdly, I'm also interested in research and getting teachers involved in research.

Jim: Did you feel you got enough information about how the project was being organised?

Loretta: Yes I felt I was kept fully informed. You contacted me regularly to let me know what was happening. Karen [research assistant] was very good about keeping in touch with us about when she was coming and yes I'd no problem with communication.

Jim: How would you describe the purpose of the project?

Loretta: The purpose I felt was that it was further development of the partnership of the College and the students and the school for the good of all working in the area of science. That it was something that would give extra support to teachers in the area that they had identified where some were lacking in confidence or expertise. It would also give students more experience in working in classrooms.

Jim: What do you feel the outcomes were for your school from involvement in the workshop held in the college?

Loretta: For the teachers there was enhanced professionalism. They were very aware of what was going on in school and they responded very well to that. It also raised their self-esteem. They were happy to be involved in the project and telling other staff about it. It helped their classroom skills in working in the area of practical, investigative science and it stimulated interest among other staff about what was going on. In the hard area of science it was useful to us, especially the outcomes of the workshops where we got specific feedback on our own schemes. The content of the workshops really came from teacher's identification of the issues and I see that in the long term being very useful to us as we further develop our schemes.

Jim: Would you continue to be involved in a similar project of this type? What changes might you suggest?

Loretta: Yes I felt it was very beneficial for the staff and the school and I would be interested in being involved. Basically I thought it went very well but no matter what you do time is always the biggest issue. Time for planning and review is as important as actual teaching. The change I would suggest is that there should be the same amount of time spent planning and reviewing of all the outcomes for the students and teachers as the time spent in the classroom.

2.4.5 School-Level Decisions

Issues are bound to arise during coteaching in schools which are beyond intervention from outside the school. For instance, in one school a student teacher was re-assigned to a different classroom teacher due to school-related demands on the former. The new classroom teacher had not been involved in any of the coteaching preparatory work and her attitude to coteaching was quite negative. Clearly, such a new way of working requires much preparation and all coteachers must be fully aware of the principles involved. We would not advocate the introduction of coteaching to participants who are not fully aware of its nature, goals and challenges. Further, we would strongly recommend that all participants sign a code of practice.

Evaluation of Coteaching

Coteaching science took place during school placements with the aim that the science expertise of the student teachers' and the classroom teachers' expertise in all aspects of teaching children were shared. The emphasis of the work done with the children was on science and technology investigations involving as much experimentation as was practicable. Several methods were used to evaluate the impact of coteaching.

All coteachers (i.e. student teachers and classroom teachers) carried out confidence audits relating to many aspects of their teaching development at the start and end of coteaching placements. Student and classroom teachers also kept reflective journals in which they recorded different aspects of their experience. They participated in the design of the respective journals at an early stage in the projects. The journal was semi-structured and asked participants to respond to specific questions relating to their experiences and reflections throughout the placement. There was a 'diary' section at the back of the journal in which participants were encouraged to record additional comments.

All coteachers were interviewed at different stages during the coteaching projects. The interviews carried out during the school placements served mainly to monitor their experiences. More formal interviews were carried out with the student teachers 6 months after the school placement to coincide with the survey of children's attitudes. The student teachers had, by the time these interviews took place, completed

their 'main', assessed 7-week full-time teaching practice in which they taught all areas of the primary curriculum. One classroom teacher from each of the participating schools was also interviewed at this time. The teachers were asked to comment on their experiences of the coteaching placement. Student teachers' practical teaching grades (which had been assessed by non-coteaching colleagues in solo taught classes, as was the case for all other student teachers who had not been involved in coteaching) were compared between student teachers who had and had not participated in coteaching.

To determine the impact of coteaching on children's attitudes to school science, approximately 250 children (8–11 years old) who had taken part in cotaught classes completed a short attitude questionnaire 6 months after the student placements had ended. The findings were compared with those from a large group of children who completed the same questionnaire approximately 9 months prior to the start of the coteaching. Both survey samples comprised similar proportions of girls and boys. For more details of this questionnaire, see Murphy et al. (2004b). To supplement the data from the questionnaires, interviews were carried out with children after both surveys. In addition, data from teachers and students involved in coteaching were compiled from reflective journals kept during the placements and from interviews that were carried out during and after the placements. We also carried out focus group interviews with small groups of children and an entire cohort of the student teachers to explore feelings and experiences of coteaching.

When the coteaching involved online learning communities (OLCs) (Murphy et al. 2004a), student and classroom teachers were trained together in the use of the virtual learning environment, '*Blackboard*'. The joint training sessions took place in the University College, and provided face-to-face contact between those student teachers and teachers who would be coteaching during the students' block school placement. Participants were introduced to a panel of subject matter experts (SMEs) who provided online support in curricular matters and with the use of multimedia in the classroom. Student teachers completed two block placements in schools in which they cotaught science and shared data and documents between schools.

2.5 Impact of Coteaching Science in Primary Schools: Student Teachers, Classroom Teachers, Children and Teacher Educators

This section presents and discusses the findings relating to the student teachers', classroom teachers', children's and university teacher educators' experiences of coteaching and their effect on primary science learning and teaching. As mentioned in the chapter introduction, we implemented coteaching primarily to address two of the main current problem areas in primary science: lack of teacher confidence in primary science and technology teaching and the decline in children's interest in school science in the more senior primary years. The coteaching projects concentrated on developing both student teachers' and classroom teachers' skills in planning,

teaching and evaluating practical, investigative science and technology lessons, including the successful integration of multimedia, to enhance children's interest, enjoyment and learning of science. As a further development of coteaching, we set up an online learning community of coteachers in schools across Northern Ireland.

We summarise some recent research into lack of teacher confidence in primary science and technology teaching and primary children's attitudes to school science. We consider how coteaching may be enhanced via the creation of an online community enabling collaboration between coteaching teams in geographically distant schools. We provide a summary of methods by which coteaching was evaluated and present the findings. The impact of coteaching on student teachers, classroom teachers and children is discussed. Findings relating to the added value that can be gained from the online collaboration of coteachers are also illustrated. Finally, the overall impact of coteaching is discussed.

In 1995, Wynne Harlen published a seminal report on primary teacher confidence in science teaching in Scotland. She reported that when teachers were asked to rate their confidence in teaching 11 subjects, science was eighth (music, information technology and technology were below science). They were less confident teaching the technological and physical aspects of the primary science curriculum than the biological topics. Teachers also reported having more difficulty with assessment of processes and of concepts than with other teaching skills (Harlen et al. 1995). These findings have been reproduced worldwide, and many initiatives have been put in place to improve the primary teachers' confidence in science. More recently, a major research study of primary teachers across the UK (Murphy et al. 2007) showed that there has been some progress in developing teacher confidence in primary science over the last 10 years. However, the situation is still critical. One half of teachers surveyed in the UK for the study identified lack of teacher confidence and ability to teach science as the major issue of concern in primary science. The report also showed that professional development in science works, in that teachers who have experienced science CPD are much more confident to teach science than those who have not.

Many reasons are suggested for teachers' lack of confidence in science and technology teaching, including insufficient subject knowledge, lack of experience in science practical investigation, lack of resources, and problems of classroom management such as overcrowding, lack of space and safety considerations. Abell and Smith (1994) studied US student elementary teachers and reported that these students were not scientifically literate and yet would be teaching science in US elementary schools. Murphy et al. (2001) showed that third-level students, including those who experienced compulsory school science from the ages of 11–16 and some with post-16 science qualifications, could not correctly answer questions in some primary science topics in tests which had been written for 11-year olds. These problems, when taken together with the emphasis of national tests on content knowledge, may have contributed to science frequently being taught as facts or as a 'body of knowledge' in the final 2 years of primary school. Teachers felt the need to prepare children for the tests by ensuring that they can recall the required content knowledge.