Curriculum materials writing: an opportunity for innovative professional development

Malcolm Welch[1], David Barlex[2] and Andréa Mueller[1]
[1]Queen's University, Kingston, Ontario, Canada and [2]School of Education, Brunel University, Twickenham, UK

Abstract

This paper describes the professional development provided by the Elementary Science and Technology (EST) partnership in response to the emerging requirements of teachers engaged in writing curriculum materials.

The paper begins with an overview of the literature, describing crucial elements in effective professional development for teachers. It continues with a brief description of the EST partnership and its links to the Nuffield Design and Technology Project. The paper outlines the various professional development experiences provided by the EST partnership in response to the emerging requirements of teachers engaged in writing curriculum materials.

Finally, the paper will describe a study in which six EST teachers adopted the role of students in a day-long sequence of activities in which a class of Grade 6 students were taught by two faculty members to design and make a product. The study addressed two research questions:

1. *To what extent does in-service training given in a classroom context help teachers acquire subject knowledge in elementary technology?*
2. *To what extent does in-service training given in a classroom context help teachers acquire a pedagogy for elementary technology?*

Keywords: professional development, design and technology, pedagogy, subject knowledge

Introduction

Single-event professional development activities (e.g. day long sessions), what Shanker (1996: 223) refers to as 'one-shot workshops' and what Little (1993: 132) calls an 'implementation-of-innovations' model, are the most frequent form of professional development for teachers. Osterman and Kottkamp (1993) demonstrate that while such professional development may be useful for introducing ideas, it does not facilitate change or noticeable improvements in classroom and professional practices. Furthermore, these single-event activities typically assume an inappropriate stance toward teacher change. They present ideas, give tips, provide handouts, project a certainty about the topic, and assume that the giving and receiving of public knowledge will lead to behavioural change. According to Little (1993: 156), single-event professional development activities 'can, at best, be used to *suggest* new classroom practices'.

The next section of this paper provides an overview of the literature describing crucial elements in effective professional development for teachers and a pedagogy to support the teaching of science and technology. This is followed by a description of the EST project, its approach to teaching science and technology, and the professional development provided to teachers in response to their emerging requirements while writing curriculum materials. Finally, the paper reports the preliminary results of a study designed to investigate the effectiveness of an in-service education experience given in a classroom in which Grade 6 students completed a design and make activity. The foci for the teachers were the pedagogy employed by two faculty instructors and the technological knowledge and skills embedded in the activity. The study addressed two research questions:

1 To what extent does in-service education given in a classroom context help teachers acquire subject knowledge in elementary technology?
2 To what extent does in-service education given in a classroom context help teachers acquire a pedagogy for elementary technology?

Professional development for teachers

Effective professional development is development that leads to positive change in the classroom, and involves four crucial elements. First, professional development must provide a challenge to teachers' frames of reference (Carney, 1998). While new professional demands, for example, those created by the introduction of a new curriculum, can make teachers receptive to new understandings and practices, they may lack frames for these situations and seek help in structuring new routines. Ball (1996) suggests that professional development must challenge teachers to investigate, experiment, consult, and consider outcomes: to take a stance of critique and inquiry toward practice. Professional development must encourage teachers to use an inquiry and problem solving paradigm that results in their producing new knowledge, rather than a training paradigm that results in their consuming knowledge.

Second, Carney (1998) suggests that new knowledge will not be learned and applied unless it is situated in relevant contexts. The notion of *situated cognition* (Brown, Collins and Duguid, 1989) is a basic cognitive principle of constructivist theory. Grossman (1992) argues that this type of learning is important for teachers; they must be able to situate new knowledge and understanding in the specific context of classrooms. Vukelich and Wrenn (1999) believe that professional development should be based on the participants' interests and needs. Cameron (1996) suggests that professional development must be relevant to actual classroom work and to what students need to know and be able to do.

Third, collaborative support from other teachers greatly increases the likelihood that changes in practice will be sustained (Fullan and Stiegelbauer, 1990). Smylie (1996) notes that since learning is incremental and teachers do not change their practices overnight, professional development should be long-range and ongoing. According to Ball (1996), teachers need time to unlearn as much as they learn. Teachers need colleagues with whom to focus on problems of teaching and learning, to work out how to deal with new subject matter, and to engage in innovative work aimed at curriculum reform (Olson, 1997; Shanker, 1996). A collaborative approach is based on notions of teachers as colleagues engaged in inquiry about practice (Lieberman and Miller, 1990; Smylie, 1996).

Fourth, professional development must provide opportunities for teachers to form 'communities of practice' (Lave and Wenger, 1991) that encourage them to reflect on the content and contexts of their pedagogy. Schön (1987) demonstrates the importance of *reflection-in-action* and *reflection-on-action* for the development of professional practice. Louden (1991) argues that reflection is a basic source of learning and change.

A simple subject construct model for technology education has been used with some success in initial teacher education (Banks and Barlex, 1999; Banks *et al*, 2000). The model identifies three areas in which new professional knowledge can be created: subject knowledge, pedagogic knowledge, and school knowledge. So the model indicates that teachers should 'know their stuff' (subject knowledge), 'know how to teach their stuff' (pedagogic knowledge), and 'know how to teach their stuff in their school' (school knowledge). This model can be used to set an agenda for professional development.

The Elementary Science and Technology (EST) partnership

The EST partnership involves a collaboration between the Faculty of Education at Queen's University and two local school boards. A three-year project, one of its primary goals is the provision of professional development for a group of teachers implementing a new Grade 1–8 science and technology curriculum (Ministry of Education and Training, 1998). This curriculum poses significant challenges for elementary school teachers about how to teach the subjects, how to assess students' learning in the subjects, and how to use the document to plan units of work (Welch *et al*, 2000; Barlex *et al*, 2000). This is especially so for those teachers who do not have a science or technology background.

The approach to teaching science and technology developed by the EST partnership has, at its centre, the concept of a Big Task (BT). A BT is a significant activity in which students have to use the knowledge, understanding and skill they have been taught in an integrated and holistic way. It forms a focal point in a teaching sequence and enables students to reveal what they have learned through what they can do. For students to be successful in a BT they will need particular and appropriate knowledge, skill and understanding. These are taught through a series of support tasks: short, highly structured and focused activities. The effectiveness of this teaching and learning is evidenced through the quality of response to the BT. This is a development of the capability task/resource task approach developed by the Nuffield Design and Technology Project in England (Barlex, 1995).

In an EST unit that focuses on science, the Big Task is called a Big Question (BQ). Answering a BQ will require students to use knowledge of science processes and concepts to collect, organise and analyse data in order to produce a reasoned argument. Students may use data from their own investigations or from secondary sources. They may present their answers in a variety of ways, for example, log book, individual or group presentations, formal report or multimedia presentations.

In an EST unit that focuses on technology, the Big Task is called a design and make activity (DMA). A DMA requires students to intervene in, and make improvements to, the made world by designing something that they themselves can make and then making the product they have designed. Both the product and the processes by which it is conceived, developed and realised are significant in this activity.

During its first 18 months, EST provided a range of ongoing professional development experiences, including practical workshops (in both science and technology), seminars, writing days, tutorials, and conversations by telephone and e-mail. In the practical workshops in both science and technology, teachers completed a unit of work (a BT and its associated support tasks) in order to gain new subject knowledge. In the seminars, teachers were able to put their professional development in the context of current educational issues (e.g. assessment, meeting curriculum expectations, and the proposed pedagogy). On the writing days teachers worked collaboratively to plan and develop curriculum units. Tutorials provided each teacher an opportunity to work one-on-one with a consultant in refining their curriculum unit. E-mail was used to maintain on-going conversations with teachers about their curriculum units as they were written. Conversations by telephone dealt with specific day-to-day problems as they arose.

The next section of this paper describes a study in which six EST teachers received in-service education in a classroom while a group of Grade 6 students were taught by two faculty instructors to design and make a product.

Method

Two faculty instructors taught a Nuffield Design and Technology unit entitled *Will this story surprise you?* to a class of 27 Grade 6 students for one school day. The teaching took place in a large classroom in the school of one of the EST teachers. The design brief for this unit reads as follows: *Design and make a pop-up book that will amuse and intrigue a particular reader. The book may be for you or for someone else.* Prior to tackling this DMA, the students completed eight support tasks to learn a variety of paper engineering techniques, illustration styles, and how to write a design specification (Barlex, 2000). The unit met the expectations of part of the Ontario Ministry of Education Grade 1–8 science and technology curriculum (Ministry of Education and Training, 1998).

A group of six teachers worked alongside the students to complete the support tasks and DMA. This afforded the teachers the opportunity to:

- participate in an approach to teaching technology
- acquire technical knowledge, skills, and understanding
- reflect on issues related to teaching and learning in elementary technology education.

Data was collected in a variety of forms and in three phases of the study. Phase 1 occurred several days prior to the unit being taught. A written questionnaire was used to identify:

- teachers' current technical knowledge and skills
- teachers' current knowledge about teaching technology.

Phase 2 of data collection occurred while the students and teachers were completing the support tasks and DMA. Teachers were asked to record their thoughts about teaching and learning technology in a prepared field notes booklet. Phase 3 occurred immediately after the unit had been taught, and had two components. First, a second written questionnaire was used to identify:

- teachers' post in-service education technical knowledge and skills
- teachers' post in-service education knowledge about teaching technology.

Second, the researchers conducted a focus group interview with all the teachers. Data from the first questionnaire and the events of the day guided the nature and structure of the focus group interview. Analysis of the focus group interview involved thematic analysis and concept analysis (Miles and Hubermann, 1994; Silverman, 1993; Strauss and Corbin, 1990).

Results

Teachers' subject knowledge of elementary technology

The first section of the pre in-service education questionnaire asked teachers to describe their knowledge of generating, developing, and communicating design ideas, their 2-D and 3-D modelling skills, and their technical knowledge of structures. Five of the six teachers reported little or no prior knowledge in these areas. These teachers reported feeling insecure about their lack of knowledge of technology content contained in the curriculum. The sixth teacher had taught industrial arts at secondary level and described in detail a high level of competence.

Data from the second questionnaire and the focus group interview indicated that because the task involved quite simple technological knowledge and basic making skills, the teachers were able to focus on teaching strategies and student responses to the tasks. For example, teachers reported that they learned quickly the paper engineering techniques. As one teacher wrote:

> At first I was a little disappointed that we were doing paper technology because although I'd never taught that stuff, it's not something that's hard for any of us to learn from a book. But on looking back I think it was actually probably helpful because it allowed me to concentrate on the pedagogy. I wasn't so worried about trying to figure out how to do it myself. (Teacher 3)

Teachers' pedagogical knowledge for technology education

The second section of the pre in-service education questionnaire asked teachers to describe their approach to teaching technology and the kinds of experiences they provided for students prior to joining the EST partnership. Teachers' responses included:

> I only taught from prepared purchased units that didn't have an end purpose. Each activity was an entity unto itself – neither rhyme nor reason for why it happened in the unit where it did. (Teacher 1)

> I would find something and think 'this looks like fun' and then dive in. We would all sort of muddle through and hope things would work in the end. (Teacher 2)

> I used to do a lot of board notes and found that I was intimidated by doing a lot of hands-on activities. Those hands-on activities that I did do were usually teacher-led demonstrations at the front of the class. (Teacher 5)

This data indicates that the Big Task-Small Task approach was considerably outside the initial pedagogic range of the teachers concerned.

Data from the second questionnaire and the focus group interviews indicates that all six teachers found observing two experienced faculty instructors engage students in making design decisions helpful as a way to understand an aspect of teaching and learning in technology education with which they had little or no familiarity. Teachers also reported that the experience was successful in helping them acquire teaching strategies for helping students to make what they had designed.

Discussion

The importance of teachers' knowledge of subject matter and pedagogy is well established in the literature (Banks and Barlex, 1999; Rosebery and Puttick, 1998). Yet subject matter knowledge and pedagogy are often fragmented in teacher education and in professional development for teachers (Ball, 2000). This study investigated the effectiveness of in-service education in context as a way to provide teachers with both subject knowledge and appropriate pedagogy in an integrated way.

In the early days of the EST project, teachers described how many of their previous professional development experiences were too removed from the day-to-day work of their teaching lives to have a meaningful impact. The approach adopted in this study was to ground teachers' learning experiences in their own practice by conducting the activity in the classroom of one of the participating teachers. Preliminary analysis of the data indicates that while in-service education in context may be a powerful way to introduce teachers to a new area of the curriculum and its associated pedagogy, it may not be an effective method for teaching new subject content. The second phase of this research project will further investigate the efficacy of the in-service education in context of the professional development model to transmit both pedagogical and subject knowledge.

As Putnam and Borko (2000) point out, a focus on the situated nature of cognition suggests the importance of *authentic activities* in classrooms. Brown *et al* (1989: 34) defined authentic activities as the 'ordinary practices of a culture' – activities that are similar to what actual practitioners do. While the teachers in this study indicated that as a result of the professional development they were feeling more empowered to teach technology, they also indicated a need for continuous support in the area of improving their knowledge and understanding of technology. They wanted more practice in tools skills, as well as knowledge of available classroom equipment and materials.

Putnam and Borko (2000) suggest that the most appropriate professional development site depends on the specific goals for teacher learning. Evidence from this study suggests that in-service education situated in a teacher's classroom may be effective in facilitating teacher understanding of new instructional practices and how to organise a classroom to teach technology.

Conclusion

The EST project provides multiple contexts for professional development, including workshops in technology, science, and writing, seminars, individual tutorials, and conversations by e-mail and telephone. The in-service education in context professional development model reported in this paper provided teachers with an opportunity to understand a pedagogic model to support learning in technology education, and how this can be enacted in a classroom. This combination of experiences is designed to provide teachers with a deep understanding of teaching and learning in technology education. As Lieberman (1995: 591) suggests, the 'conventional view of professional development as a transferable package of knowledge to be distributed to teachers in bite-sized pieces needs radical rethinking'. Evidence from the EST partnership suggests that a combination of approaches situated in a variety of contexts holds the best promise for fostering powerful changes to teachers' thinking and practices in terms of their pedagogical and subject knowledge.

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