Research Article

Personal Development Profiles and Models of Learning in Teachers' Continuing Professional Development in Primary Science, A Case Study from the Centre for Science Education, Open University, UK.

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Summary. *Guidelines issued by the Department for Education and Employment in the UK have maintained that programmes of Continuing Professional Development in Science (CPD) which qualify for special funding from Government must have as a priority the development of a personal knowledge of science by the participating teachers. This paper is concerned with finding measures of the progress which could define teachers' progress as they strive to develop and apply an enhanced personal knowledge of science to practice. It also aims to identify some of the key elements which contribute to successful CPD in primary science.*

Working with more than 400 teachers over a period of three years, the following measures were set in place and then examined, to look for evidence of progress in the acquisition of science knowledge and a resultant change in the practice of teaching science within the primary curriculum:

- responses to tutor-marked assignments (TMA's)
- end-of-course evaluations
- entries in reflective diaries.

Responses to assignments
The type, level and range of skills being displayed by teachers in three episodes of assessment during an Open University CPD Course in Primary Science were used to construct a framework for illustrating the potential for teachers to achieve a personal development profile in science and science teaching (see Figure 1).(See Tresman et.al.1997)
Participants progress through the course could then be tracked by plotting their acquisition of core skills (as demonstrated in their response to the assignments) with time.

Core skills included:
research experience/teacher as researcher
organisation
communicating
writing
record keeping
scientific knowledge in key areas supporting Key Stage 1 and 2 of the UK National Curriculum, e.g. Life, Diversity and Evolution, Materials, Energy & Forces, Electricity, Planet Earth, Ecosystems & Environment.
practical skills

The complexity of the assessment tasks and level of skills being tested increased with time, culminating in a substantial end-of-course project. (See Figure 1. (Tresman et.al. 1997 and 1998.))

A quantitative measure of performance on each of these assessment events was then obtained for a pilot sample. Such early results would appear to indicate that teachers with varied levels of science qualifications, are able to achieve similar levels of attainment in a course of professional development in Primary Science. The results also enable the formulation of a model of learning during Programmes of CPD that comprises a personal learning journey through five phases as detailed in Figure 2. Encountering these five phases enables teachers to access the post training experiences indicated in the sixth and seventh column to the right of Figure 2.

Reflective Diaries
What do teachers say about the relevance, as they perceive it, of an enhanced personal understanding of science to teaching it in primary classrooms?
Information was collected about the perceptions of more than 100 teachers engaged in primary science CPD. The data was obtained using a technique in which teachers wrote reflective diaries on their experiences on six INSET courses with four separate providers.
We were interested in what common threads might emerge from groups working with different tutors on different programmes in different parts of the country. In all, several thousand diary entries were produced, reflecting on their experiences. These illustrated the major issues addressed by teachers and tutors engaged in Courses of Continuing Professional Development lasting between 5 and 20 days. (Tresman and Fox 1996 for a full account of research and extracts from reflective diaries).
The key issues were as follows:

- Science is difficult, and the most difficult concept is force and the various concepts related to and derived from force - including floating and sinking, weight and density. This difficulty was expressed both in terms of personal understanding and introducing it into primary classrooms.
- The application of force can be readily experienced and teachers were enthusiastic about making, calibrating and using a forcemeter.
- Teachers placed great value on practical work which they could engage in to progress their own understanding. This seemed to be a process by which teachers moved from early positions of anxiety, misconceptions and difficulty with concepts to more enlightened and confident

Table 1. The two student subgroups with TMA and Student Project Scores.

				Assignment Marks / 100				
ID Code	**Region**		**Returned Questionnaire**	**TMA01**	**TMA02**	**Project**	**Grand Total**	**Highest Science Qualification**
□ 3 O-levels		**Passmark**		**40**	**40**	**40**		
3	2		Yes	82	62	67	211	3 O-levels
4	2		Yes	78	60	55	193	1 O-level
7	2		Yes	67	72	87.5	226.5	1 O-level
14	5		Yes	88	88	83	259	3 O-levels
15	6		Yes	59	66	46	171	1 GCSE
16	6		Yes	68	77	69	214	2 O-levels
17	6		Yes	57	85	85.5	227.5	None
21	6		Yes	46	55	65.5	166.5	None
22	6		Yes	67	82	71	220	1 O-level
23	6		Yes	49	56	62.5	167.5	1 CSE
26	10		Yes	45	47	58	150	1 O-level
28	10		Yes	76	63	73.5	212.5	1 O-level
Mean				**65.2**	**67.8**	**68.6**	**201.5**	
□ 1 A-level								
20	6		Yes	57	55	53	165	2 A-levels
33	2		Yes	79	59	57	195	1 A-level
38	2		Yes	93	95	83.5	271.5	1 A-level
40	2		Yes	46	60	53.5	159.5	BSc
41	2		Yes	84	93	77.5	254.5	MSc
Total			**18**					
Mean				**73.2**	**74.2**	**64.9**	**201.4**	
Total Mean				**67.8**	**69.9**	**67.5**	**201.5**	

positions.

- Electricity was the form of energy most often indicated as being difficult, but teachers typically reflected favourably on opportunities to experience practical sessions with appropriate equipment backed by 'content' session on related theory.
- More comments were made about the relevance of CPD courses which concentrate on developing enhanced personal knowledge in science, than any other issue, i.e. in order to sustain motivation, courses had to be seen to be relevant to science needs of primary teachers.
- There was some recognition about the more indirect relevance of teachers reflecting on the valuable insights they were gaining from their own experiences as learners.
- A majority of comments focused on the way teachers would take experience of the course into the classroom.
- The notion of relevance was perceived by many to include responsibilities of co-ordinator or subject leader roles.
- The issue of levels - adult ... children's was central to the issue of relevance. Some found it very difficult to focus on the longer term aims for their practice of an enhanced personal knowledge of science. Their compulsion to find classroom relevance detracted from the opportunities for learning at their level. Role of tutor or course materials was crucial in successfully mediating and negotiating these longer-term aims.
- Groups were always composed of teachers with varied science backgrounds, and many teachers found that previous experience had not provided them with the understanding they had previously assumed.
- Successful courses designed into them activities targeted to making teachers question existing concepts and resolve partial understandings/ misconceptions.
- Sufficient emphasis was needed on the time-demanding processes of science. Many important processes can be practised without traditional practical activities requiring equipment and materials e.g. hypotheses framed, planning carried out for experiments, analysis and interpretation of data, conclusions drawn.
- Teachers expressed feelings of increased confidence to handle science in the classroom as they become more knowledgeable about science. By the end of their programmes of professional development, most participants recognise that they have participated in a significant route to improving the quality of their classroom practice. They recognise that science is difficult but are prepared to meet the challenge.

Some additional perceptions were revealed in a study of end of course evaluations. These included, (1) the high

Figure 1. Personal Development Profiles for Primary Teachers participating in the OU Course 'Primary Teachers Learning Science' : An Illustration.

		Core Skills						
TARGETS SET BY STUDENTS IN THEIR END OF COURSE PROJECTS		Assessing the consequences for teaching of new knowledge. Sustained changes in science teaching; impact on practice.						Baseline assessment of competence = pass continuous assessment (TMAs 01 & 02) and examined component (The Project)
	(	New targets						
	(	Evaluating achievements						
	(	Reflecting on learning.						
Tested in TMA03	(							
	(	Teacher as researcher					<u>Pass</u>	
	(	disseminating new knowledge.						
	(	Supporting colleagues						
	(	Managing science in the school.						
	(	Planning research work.				<u>Pass</u>		
	(	Reflective learning for teachers						
Tested in TMA02	(	writing skills. Teaching						
	(	investigative science.						
	(	Monitoring learning outcomes						
	(	for children. Record keeping.			<u>Pass</u>			
	(	Organisation and						
	(	communication of ideas in						
Tested in TMA01	(	science. Scientific knowledge.						
	(	Children's ideas. Learning						
	(	outcomes from activities						
		Various starting points in basic skills in science						
					Assignment 1	Assignment 2	The Project	Post course agenda and new professional targets
			Orientation	Familiarisation	Immersion Phase	Reflective Phase	Bridging to practice	Application Phase

Figure 2. A model for learning during programmes of continuing professional development

orientation phase ∅	familiarisation phase ∅	immersion phase ∅	reflective phase ∅	bridging to practice ∅	POST-TRAINING EXPERIENCES application to teaching, longer term impact on practice ∅	Greater Understanding of Children's learning
•reflecting on professional situation •verbalising, assessing, auditing current knowledge and perceptions of purpose of teaching science in primary curriculum •expectations, needs and targets for course consequences of present knowledge for key tasks you are involved in •fixing time lines and organising workload •reassurance •motivation - role of tutor/course materials long term aims	•breaking down barriers •confidence building •showing science to be accessible •raising awareness of contribution personal knowledge of science can make to practice •familiarity of possible outcomes of learning for teaching •guidance on the processes of learning, reflection, active learning, group interactions	•learning key concepts in science skills and processes of science •working with course materials •mixed media resources •designing and participating in tutorials •completing assignments •correcting misconceptions •increased confidence in confronting new and difficult ideas in science	•analysing processes of own learning •trying alternative learning strategies at personal level •opportunities to access and record progress in personal learning •requirement to focus explicitly on using own knowledge to change teaching •collecting evidence to show how developing scientific knowledge is enhancing professional role(s) •focusing on personal achievements	•process new information insights and experiences into classroom strategies •test new ideas, record (for assignments) •critical evaluation of new practice, through stages and sequential tasks within framework for course assessment •considering consequences for teaching of personal achievements •creation of new 'building blocks' for primary practice •effective questioning and intervention to diagnose children's partial understanding and misunderstandings	•long term-post course, but where framework is established within an assessed course •reflecting on changed professional situation and appropriate future targets •support and dissemination techniques gained through course to enable work with colleagues	•management of opportunities for learning science in the school •confidence in eliciting children's ideas and analysing them in order to plan activities •judging influence of teaching on the development of children's scientific ideas •teacher as researcher - sharing new knowledge in the science education community

Table 2. An Example of a Ten-day Government funded Course.

TERM 1		**BBC/OU RESOURCES**
June	Pre-course twilight - introduction to proposed course, staff etc, attended by course participants and Headteachers 2 day introduction to course	
Late September	Ways of studying the workbooks. OU assessment for the Certificate. Introduction to the learning file and assignments Audit of science skills of course participants Diversity and Evolution tutorials and workshop Investigative work in science, reporting on and recording children's achievements and experiences	Workbook 1: Life: diversity and evolution Assessment booklet Teaching Today [1] Broadcast and Notes
October	1 day, tutorials and workshop on materials	Workbook 2: Materials: Physical and Chemical changes Teaching Today [2] Broadcast and notes
Late October	1 day in school researching tasks with children and preparing for course assignments 1 and 2 (with supply cover)	
November	1 day, tutorials and workshop on Forces and Energy	Workbook 3: Forces and Energy Teaching Today [3] Broadcast and notes.
ASSIGNMENT 1 DUE NOVEMBER		
Early December	1 Day workshop and tutorials Continuing Forces and Energy Differentiation in primary science Working with colleagues, school based INSET - strategies for and evaluation of (production of A$ resource sheets by course participants to be shared amongst all members of the group)	Workbook 3: Forces and Energy Workbook 2, Section 4
TERM 2		

January	1 day workshop and tutorials on Circuits and Magnets Planning for science, providing equal opportunities for science (5 minutes presentation by course participants)	Workbook 4: Electricity: Making connections Teaching Today [4] Broadcast and notes

ASSIGNMENT 2 DUE MARCH

February	1 day workshop and tutorials The Planet Earth Resourcing primary science	Workbook 5: the Planet Earth Teaching Today [5] Broadcast notes
Late February	1 day in school (with supply cover) researching tasks for assignment 3	
March	1 day workshop and tutorial on Ecosystems Assessment in science	Workbook 6: Ecosystems Teaching Today [6] Broadcast and notes
Twilight late March/April	Exhibition mounted by course participants in local professional development centre for Heads, Colleagues, Pupils, future course participants.	

ASSIGNMENT 3 DUE AUGUST

AWARD BOARD MEETS NOVEMBER TO OFFICIALLY AWARD CERTIFICATES

level of value placed by teachers on tutorials which explained specific scientific concepts in a non-threatening environment. (2) Tutorials should be held in the company of experienced tutors of adult learners (in these cases combinations of Local Education Authority science advisory staff and Open University science tutors). (3) Acknowledgement of the large amount of time needed for study and work for assignments. (4) The appreciation of high degree of organisation needed by teachers to synthesise their study, to reflect on the use of the science in school and to try out ideas for assignments in the classroom. (These sentiments were influential in validating the course as a post graduate certificate within the Open University's MA in Education.)

On the basis of research outlined above,the following are identified as critical aspects of training programmes in primary science. Programmes which include these factors should enable teachers to achieve success in learning science and applying it to their practice in school and classroom.

CRITICAL FACTORS

1. Explicit links should be made, between selected content at the level of the adult learner and the potential for this to impact on primary science practice. This link must be included in the course resources and tutorial provision.
2. Techniques for reflective learning should be introduced at an early stage.
3. Explicit statements on core skill and subject specific outcomes should occur at key points in the programme of training.
4. There should be opportunities for teachers to record evidence of their progress in learning/applying science.
5. Opportunities should be provided for teachers to demonstrate the processes involved in their development of new science knowledge (the personal learning strand).
6. Opportunities should be provided for interaction with concepts/activities in workbooks/course materials and tutorials - especially core skill activities, which can feed into course assessment.
7. The role of the tutors is central to establishing the quality of the learning experience through providing appropriate tuition and feedback. This requires adequate levels of support for tutors with quality assurance checks being built into the system.
8. CPD courses need to include needs analysis and audits of knowledge, and providers should use this data to establish differentiated provision for teachers with varied backgrounds.

9. Support of head teachers and senior/other colleagues is crucial in the reconciliation of personal needs of participating teachers and priorities of school development in science.
10. A sequence of assessment tasks focused on practice which involve critical evaluation of teaching and a coherent, progressive guided set of tasks across a period of months facilitates maximum impact on practice.
11. The provision of a framework for assessment which allows participating teachers to function as researchers within the context of a project at the end of the course. (Tresman et.al. 1997.) (Gibson, 1996.)
12. The design and implementation of an appropriate and varied tutorial programme e.g. Table 2 preferably through establishing partnerships between teachers, schools and Higher Education Institutions. (Gilroy and Day, 1993.)

On reflection: A model of learning

A number of critical factors have been assimilated into a model of learning shown in Figure 2. This model is relevant to the design of programmes of primary science professional development, established to meet UK Government guidelines (1990 onwards), but may contain appropriate guidance for all providers of Continuing Professional Development in primary science wherever they are working in partnership with practising teachers.

References

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