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Learning-focused Curriculum Development: the redesign of elements of a PGCE Science (Subject Year) Programme

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Introduction

Learning allied to assessment is the pivotal focus of this project aimed at enhancing a professional course for Science teachers. The PGCE Secondary Science course has two routes. The one-year route follows the typical PGCE programme of study leading to Qualified Teacher Status (QTS). The two-year route provides an initial year (the Subject Year), primarily for developing subject knowledge in all areas of School Science.

The Subject Year enables people to pursue a career in Science teaching who might otherwise have been excluded on the basis of their previous academic background and experience. It is designed for graduates whose degree may not closely match with National Curriculum Science (DfES, 1999) at secondary level, but whose previous studies at post 16 level and beyond include some significant and relevant study of Science. For example, a degree in Agricultural Science or Psychology might not provide sufficient breadth to enable confidence and security with the breadth of Science required at GCSE level. A graduate of Geology might lack a background in the Physical Sciences at Post 16 level. This additional year strengthens subject knowledge across a breadth of Science closely aligned to the National Curriculum for Science. However, there are other less explicit aims, such as further time to become familiar with UK educational systems and teaching approaches, and development of communication skills. It is therefore particularly suitable for many applicants from ethnic minority communities.

Cultural and geographical backgrounds of the students are diverse. The students also bring a wealth of different experiences to the course due to differing ages, degree backgrounds, and very different educational experiences. For many, English is an additional language. Consequently it presents a considerable challenge to meet these diverse needs with the only common ground being the ambition to teach and a degree background with some aspect of science.

Although the majority of previous students expressed satisfaction with the programme, the relevant evaluation questionnaire did not directly elicit the value of the school experience, and evaluation takes place before students have had the opportunity to consider continuity and progression into the professional year (second year) of the course. External examiner feedback reiterated my other concern that we should seek to minimise any repetition of learning outcomes from the subject year to the professional year of the course.

The Teacher Training Agency (TTA) has been piloting other methods of subject enhancement, namely the pre – initial teacher training subject enhancement courses in Physics and Mathematics enabling applicants with a wider range of degree backgrounds to train as Science teachers. There is a concern that these enhancement courses could affect recruitment to two-year route PGCEs, as students on the enhancement courses will receive a bursary – although tuition fees for the PGCEs are funded by the TTA. It is our belief, endorsed by the TTA, that our two-year route provides and caters for wider needs than subject knowledge and is therefore more appropriate for particular students. It is vital that the additional year provides a worthwhile learning experience for applicants and addresses deficiencies that prevented applicants' admission to the one-year route PGCE.

The main objectives of the project were to:

- establish the gap in skills, knowledge and experience between recruits to the one year and two year route;
- review whether the learning experiences provided by the taught modules and school experience redress the identified gaps;
- redesign the first Education module, "Communicating and Learning Science", that runs alongside the Science modules (on the fundamentals of Physics, Biology and Chemistry)
- propose ideas for longer term course evaluation that would enables us to consider the usefulness of the Subject Year for new entrants to the teaching profession.

Approach to curriculum development

A "logical model" of curriculum development has been adopted (Cowan and Harding 1986). This model "calls for virtually simultaneous consideration of the desired learning outcomes, the proposed means of assessment and the design of suitable learning and teaching (in that order)" (Cowan el al. 2004, p450). It draws upon other research showing that assessment influences student learning, well ahead of the declared aims and learning outcomes.

The Education module assessment components included an essay about planning issues and a portfolio of lesson plans, lesson observations. My concern was that the brief for these tasks was too similar to that required by the professional year.

Overall, the response to the essay was poor, with a majority of students unable to demonstrate application of knowledge and understanding, merely paraphrasing. Although, this could, in part be attributed to weak academic writing skills some modification of the essay brief and grading criteria seemed necessary. Likewise, the portfolio tasks needed to be reviewed in terms of what students should learn and how they could manifest that learning, coupled with planning for opportunities that would place students in situations likely to elicit the required learning as "performances of understanding" (Biggs 1996).

The Education module looks closely at the application of constructivism to Science teaching and learning, drawing upon the work of the late Rosalind Driver (Driver, R et al 1994), and Leach and Scott (2001), and so it is appropriate to model this philosophy. The module teaching and learning activities model a constructivist approach and the taught course reflects the view, encapsulated by Bigg's (1996), that "learners arrive at meaning by actively selecting, and cumulatively constructing their own knowledge, through both individual and social activity".

I have sought to enhance the importance of deep learning through use of a constructivist approach. Greater use of the content from the corresponding science modules in the semester to exemplify the taught pedagogical approaches could also serve to provide additional subject knowledge development and deeper learning. According to Ramsden (1992) one way to encourage 'deep' (meaningful) rather than 'surface' (rote) learning is to stress the meaning and relevance of the subject matter to students. For example, if students are given the opportunity to discuss and reflect upon the benefits of *the conceptual change approach* in school science teaching and learning, then they will also be compelled to examine their own understanding in science and identify and overcome some misconceptions that they hold. The principles of "constructive alignment" of learning outcomes, teaching and assessment methods (Biggs 1996) can be usefully applied to the module assessment activities, and 'a performance notion of understanding' when deciding grading categories.

Towards a redesign

My starting point was establishing the knowledge and skills that the Subject Year needs to develop, to enable students to progress to the one-year PGCE route, and which of these are covered by the Education module in particular. The purpose of this exercise was to see whether there were areas not addressed by the whole course, and to what extent the Education modules included content that was beyond the realisation of overall course aims. Encouragingly, the audit confirmed the course is addressing that which is required for progression (see **appendix 1**). However, the Education modules and school placements (four days spread across the term) go beyond many of aims described by the progression criteria. There is clearly a danger of repetition with the content of the second (professional) year of the PGCE.

In an attempt to compensate, a greater emphasis in the teaching, learning and assessment tasks associated with the first Education module and school experience has been placed on strengthening subject knowledge understanding, through consideration of 'Communicating and Learning Science'. These tasks were reviewed using an "alignment matrix" (Cowan et al, 2004), first to identify and then to tackle discrepancies and omissions (see **appendix 2**, developed alignment matrix). I decided to focus on the declared outcomes and aimed to provide much closer alignment with the assessment items, within the constraints of the present assessment components and weightings. This is in accordance with the "logical model" of curriculum development advanced by Cowan and Harding (1986), in which early attention in planning is given to assessment.

The initial design of this module would probably have followed a chronological sequence, with assessments coming later in the order, as encountered by the designers, teachers and learners. My own experience of curriculum development in secondary schools suggests that this "chronological model" of curriculum development, as described by Cowan et al (2004), is a typical response to module design under the pressure of meeting deadlines for approval by external bodies. Toohey (1999) outlines a standard chronological model that essentially proposes the sequence of teaching followed by learning, assessment and finally evaluation. A prime goal of this project has been to improve the learning experience, with an active approach to learning. I am therefore in agreement with Cowan (2004) that there are problems with a chronological sequence, as it places the emphasis on 'teaching being the main input to learning'. The Education module lends itself to the "logical model" of curriculum development, with its school experience days. I have placed an emphasis on considering how learning will occur and how assessment will influence learning and used this as a starting point for redesign.

Redesign of the assessment tasks has allowed for improved alignment. Biggs (1996) notes that constructivism strongly implicates the use of an assessment portfolio where students can select evidence to demonstrate learning outcomes. In the Education module, justification of such selection for their portfolios, and their use of the learning diary, will provide evidence of the students' depth of understanding and quality of reflection (see **appendix 3** for the redesigned assessment tasks). The school experience tasks give a focus for each day on placement, which should enable the students to elicit the required outcomes. For example, on Day 3 the focus is 'The Use of Practical Work in Science'. The students are instructed to observe as many practical sessions as possible and then, in the allocated task, to draw upon their observations to "reflect upon the role of the experimental work used and consider the issues involved in the management of class practical lessons". The school mentors are briefed on the type of classroom situation that will enable the student to demonstrate and reflect upon their own development with respect to the learning outcomes. The essay brief and grading criteria have been modified to provide closer alignment with the module outcomes and also to encourage students

to demonstrate a *performative notion of understanding*. It requires an application of the module content in the context of planning to teach a particular Science topic.

Teaching and learning activities, as detailed in the developed alignment matrix (see **appendix 2**), have been selected to maximise student activity and encompass a wide range of self, peer and teacher directed activities. There is an emphasis on discussion in pairs, small groups and as a larger group, in recognition of the need for social interaction in the construction of knowledge and understanding.

Finally different methods of evaluation have been proposed, recognising the limitations of the present model. Questionnaires can reveal minimal information for a small cohort and this can be enhanced with an increased use of focus group discussion, feasible with a cohort of this size. A specific focus for the module evaluation will be to look at whether there has been a change in how students perceive science and how pupils and themselves' learn science. Feedback from students at a later stage will provide further indication of how well the course has redressed the individual needs identified at interview. The audit of progression criteria (in appendix 1) was a powerful tool for establishing the overall course aims as well as providing a quick means of review. This could also inform the evaluation questionnaire for students beginning teaching after completion of the Subject Year. The use of the alignment matrix approach has been invaluable. It provided a very clear picture of the shortfalls with the existing assessments and identified the starting points for the learning-focused redesign of the chosen module.

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Biographical note

Victoria Brook taught Science and A-level Chemistry in inner London secondary schools for 20 years prior to becoming a PGCE Secondary Science course tutor and lecturer in Science Education at London Metropolitan University. Her interest in "widening participation" began when teaching in secondary schools and managing the provision of vocational courses and alternative access routes to HE. **Email**: v.brook@londonmet.ac.uk

APPENDIX 1: Criteria for progression to the *professional* year

The following codes appear after each criterion to denote where the criterion is mainly addressed: *S.M = Science modules, E.M = Education modules, S.E = School experience, EAP = English for Academic Purposes*

1. Subject knowledge

1. Ability to demonstrate knowledge and understanding in key areas of Physics, Chemistry and Biology at a level higher than GCSE. *(S.M)*
2. Knowledge and understanding of important and current applications of Physics, Chemistry and Biology. *(S.M)*
3. To demonstrate competence with the mathematical operations required within the areas of Science studied. *(S.M)*

2. Experimental Skills

1. Competence in using a range of laboratory equipment from the three main disciplines in Science *(S.M)*
2. Ability to obtain data using precise measuring techniques *(S.M)*
3. Competence in data handling and analysis *(S.M)*
4. Can undertake risk assessment and work safely. *(S.M)*

3. Skills as a Science Educator

1. The potential to support pupils in all the requirements of the GCSE syllabus. *(E.M)*
2. Understanding that key concepts in science are often counter-intuitive
3. The ability to communicate and explain key concepts in Science. *(E.M)*
4. Appreciation of why Science is perceived as difficult. *(E.M)*
5. An appreciation of the Nature of Science *(E.M)*
6. Breadth of interest in Science + openness to the Nature of Science as a subject *(E.M)*

4. School Experience

1. Recent experience within a secondary school environment *(S.E)*
2. Realistic awareness of the challenges within inner city schools *(S.E)*
3. Awareness of current teaching approaches and styles *(S.E/ E.M)*
4. A working knowledge of the Science National Curriculum (E.M)
5. Ability to reflect upon and evaluate teaching and learning (E.M / S.E)
6. Demonstration of analytical thinking in relation to teaching and learning (E.M / S.E)

5. Academic skills

1. The ability to summarise and extract ideas from academic texts. *(EAP*)
2. The ability to plan and write coherent essays. *(EAP /E.M)*
3. The ability to keep a concise and accurate log. *(EAP / E.M)*
4. The ability to think reflectively. *(EAP/E.M)*
5. The ability to evaluate new ideas *(EAP / E.M)*

6. Personal skills

1. The ability to communicate effectively *(E.M/ S.M/ S.E/ EAP)*
2. The ability to collaborate as a member of a group *(E.M/ S.M/ S.E/ EAP)*
3. The ability to lead a group *(E.M/ S.M/ S.E/ EAP)*
4. The ability to learn from constructive criticism *(E.M/ S.M/ S.E/ EAP)*
5. Personal confidence e.g to stand up in front of a class
6. The ability to demonstrate respect for opinions + ideas of others *(EM/SM/SE/EAP)*

APPENDIX 2: Developed Alignment Matrix: Communicating & Learning Science

Learning Outcome	Learning and Teaching Activity	Assessment
Understanding of issues concerned with explaining and communicating scientific ideas	Pre session reading and note taking Trialling explanations of key concepts (pairs)/Pairs to four to raise issues. Whole group discussion of key points School based tasks looking at various modes of communicating Science in the classroom Use of learning diary to record critical incidents in the classroom	Essay – considering and applying these issues in lesson planning Portfolio: learning diary
Understanding of aspects of relevant learning theory	Pre course reading Presentation of key points from theories Groups to consider examples and apply the theory	Essay- linking relevance of consideration of how pupils learn and application to lesson planning
Understanding of issues of process and progression in terms of scientific development; the role of pupils' prior learning and the building of scientific concepts, drawing on research in science education	Reviewing research on commonly held misconceptions Group activity to build up sequences of statements about key ideas in science showing progression in understanding. Groups to compare and then compare with N.C. Misconceptions video and discussion School based tasks – misconceptions Learning diary -listening to 'pupil talk'	Essay- linking issues to lesson planning Portfolio: School based tasks: commonly held misconceptions Learning diary
The role and development of investigative skills in science	Planning and carrying out an investigation. School based tasks – use of practical work	Portfolio: School based task: use of practical work in science and reflection on role of investigative work
Understanding of links between scientific ideas, evidence and explanations and historical or contemporary examples	Use a story in Scientific development to model the 'Nature of Science'. Case Study work (pairs) and development of lesson plan.	Portfolio: Application of Case Study to a lesson plan. School based task: to trial plan
Understanding of National Curriculum and exam syllabuses in relation to learning processes	School based lesson observation tasks	Portfolio: School based task- lesson observation notes reporting use of N.C/GCSE in setting objectives

Skill in setting up practical demonstration and practical activities	Lab work. Practise demonstrations. (Micro teaching) School based task	Portfolio: School based task: Perform a demonstration and evaluate your performance
Skill in critical evaluation of science teaching resources and the important features of a science teaching resource	Groups to draw up criteria drawing upon school experience. Review range of different resources. Report back. Pairs to design a simple resource suitable for a small group of pupils School based task to review use of different resources	Portfolio: Use of critical evaluation in own design of teaching resource
Use of ICT for producing and assessing learning materials	ICT session Complete design task	Portfolio: Presentation of design of resource

APPENDIX 3 : REVISED ASSESSMENT TASKS

Learning and Communication in Science

Your assignment is in two parts: 60% essay, 40% portfolio

Essay Title

" The key issues of planning in teaching and learning Science at Key Stage 3"

Essay Brief

'We believe that that in developing the skills to identify and talk about learning demands in different parts of the school curriculum, then all science teachers can become better equipped to plan teaching approaches which create and sustain the meaningful dialogues which are fundamental to good teaching and effective learning.'
(John Leach and Phil Scott in '*The Demands of Learning Science concepts*' in '*Teaching Science in Secondary Schools*' edited by Sandra Amos and Richard Boohan)

Choose one area of science from the KS3 Programme of Study. (You may decide to choose one of the QCA topics) and discuss the key issues of planning in the teaching and learning of this topic. Your essay must:

- Demonstrate a knowledge and understanding of aspects of relevant theories on how children learn in science
- Demonstrate a knowledge and understanding of the issues concerned with explaining and communicating scientific ideas
- Show insight into the use of "learning demand" in planning for teaching and learning in the chosen scientific area.
- Show awareness of the importance of variety in teaching and learning activities in the classroom with examples given
- Refer to appropriate reading and the taught course, including familiarity with some of the ideas and structure of the Key Stage 3 strategy for Science
- Use appropriate academic English

Essay length: maximum 2,500 (Please show word count)

Portfolio – This is a sample of your serial day placement work (40%)

Your learning diary

1. This should be a reflective account of your own learning. Try to consider the module learning outcomes and your own subject knowledge enhancement (40%)

2. **Four** of your serial day placement **tasks** written up with reference to appropriate reading (60%)

Assessment Criteria

Learning Diary

0%-10 % The diary is very incomplete and fails to provide a satisfactory account of learning and development from the school experience days

10% – 20 % There is an account of some learning and development, mainly descriptive.

20%-30 % The diary provides a good account of learning and development that is closely linked to the learning outcomes. There is clear evidence of reflection within the account.

30% – 40% The diary provides an excellent reflective and thoughtful account which takes good consideration of the learning outcomes.

Tasks

Each task is worth 15 %. Marks are awarded for evidence of reflection and evaluation with reference made to the taught course and appropriate reading.

Student Briefs (Assessments as outlined for students in the handbook)

Learning Diary

You must keep a diary that reflects upon your own learning experiences. This should be in relation to the expected learning outcomes for the appropriate Education module and in relation to your subject knowledge development.

Portfolio of Evidence

This is one of the assessment components for the Education modules. You will select written evidence from the school based tasks with a justification of your choice. It also includes your learning diary of your experiences during these days.