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Thematic Curriculum Design, a case study: the Chemistry Subject Knowledge Enhancement Course

Roussel De Carvalho
(formerly) Faculty of Social Sciences & Humanities
London Metropolitan University

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Introduction

This article discusses the curriculum re-design of the Chemistry Subject Knowledge Enhancement course in teacher education, in order to address issues raised by former students. It used a thematic approach and focused on pedagogical content knowledge (PCK) and the development of student-teachers' teaching and learning skills. The main outcomes of the project were the deeper and more meaningful experience that student-teachers had during the 25-week period and the successful implementation of a longer school experience. The external examiner's report was very positive and demonstrates that the efforts placed in this re-design has provided an invaluable experience for student-teachers as the enter their professional PGCE year.

The Chemistry Subject Knowledge Enhancement Course (SKE) is a 16-unit course with multiple entry points throughout the six months in which it runs. Atypically, it does not have a set curriculum standard and it is not controlled by the Teaching Agency. Currently, providers are able to develop their own standards, curriculum and monitoring systems. Furthermore, it is not formally assessed and students are only required to 'successfully complete the course'.

Technically, the SKE offers student-teachers the chance to further develop their subject-specific knowledge. However, previous student feedback revealed that the SKE as 'too academic', 'too high level' , 'no actual teaching practice' , 'it was content overload' and 'did not take into account our future career as teachers'. These clearly show that the course did not provide the appropriate level of subject knowledge for teaching. Therefore as the new PGCE Science course leader I made the decision to modify and re-design the course content and structure to suit students' needs within the context of the PGCE Science.

A decision has been made to also develop pedagogical-content knowledge (PCK) (Shulman 1988) of the secondary school curriculum. This will allow students to understand the level of knowledge required at secondary school, understand the pedagogical underpinnings of school-related tasks as well as move their own subject knowledge forward. This is important in order for the student to arrive at the PGCE-chemistry with a familiar understanding of the required level of expertise. Moreover,

"…the ways in which teachers interact with their students depend on their own knowledge and beliefs about teaching and learning. Studies often identify three main forms of knowledge related to teaching – about subject matter, teaching and managing learning, and relationships with the learner (Wittrock, 1986). Shulman (1987) argued that a combination of content knowledge and pedagogical knowledge – pedagogical content knowledge – plays a crucial role…

(Entwistle and Smith, 2002, 329)

Thus, the SKE must be a pivotal part of the student-teacher progress towards forming a better picture of school science knowledge and teaching rather than a systematic accumulation of chemistry content knowledge.

Thematic curriculum approach

A thematic curriculum approach was decided upon because it 'encourage[s] a shift from teaching concepts and structure alone, to teaching scientific thinking skills as well' (Lijnse et al. 1990, 96). It contextualises teaching and learning in order to engage students about the real world, rather than the abstract concepts of science. The development of a thematic curriculum means that students will have opportunities to learn through more contextualized learning experiences and opportunities to explore a wide range of authentic, real-life science experiences. Furthermore, a Chemistry Subject Knowledge curriculum should attempt to give student-teachers an academically sound as well as current and sound pedagogical content knowledge of chemistry, since it plays a key role in the development of our society. For example, chemistry teaching should enable student-teachers to learn about the structure of matter and the different strategies which could be used in the classroom to develop students' cognitive abilities without resorting to "chalk and talk". Moreover,

"…Structuring teacher education in terms of how teachers learn requires organising the curriculum in a scope and sequence that capitalises on teacher development – moving from a focus on self to a focus on student learning and from the foundations of learning theories to the implications for teaching. It also means finding ways for teachers to learn about practice in practice, so that concrete applications can be made and problems of practice can be raised, analysed and addressed…" (Darling-Hammond and Baratz-Snowden 2005, 31)

Student-teachers should grasp chemistry as a something that permeates our lives. This would allow them to create meaningful learning episodes which would link scientific knowledge with a more socio-economic, cultural-historic understanding of chemistry, making it relevant to their students. Student-teachers must be involved in our lessons within a thematic curriculum that has at its core the development of the whole teacher rather than just a 'subject-knowledge' container, as teachers have a responsibility to deal with a plethora of value-laden decisions within their classroom that has the potential to influence their students' outcomes.

Furthermore, a thematic curriculum can be a way to

*'…describe the richness, depth and breadth of what students might learn through engagement with a given subject area in a specific context. This might include, for example, coming to terms with particular understandings, forms of discourse, values or ways of acting which are regarded as central to...mastery of a discipline or subject area…' (*Entwistle, Nisbet and Bromage 2005, 176)

Additionally, teachers must be able to develop the skill of choosing from a range of appropriate learning strategies in order to be able to cope with students' needs. These strategies are able to shape classroom interactions and hence, the inherent classroom climate becomes another important variable in students' engagement and intellectual development (Padget 2013). Therefore, this subject knowledge enhancement course must address not only subject knowledge issues but also promote strategies which student-teachers are able to reflect on, adapt and use it in the workplace.

The starting point of any curriculum development process must start with the basic models which are already in place. For example, Tyler's (1949) and Taba's (1962) models have made very significant contributions over the years. Although, starting by looking at desired outcomes (Tyler) or students' requirements (Taba) may have its advantages, it narrows the designers tools for pathways which may lead to a non-linear progression of curriculum. Furthermore, the spiral curriculum (Bruner 1960) has had a huge influence in the English National Curriculum, and although it has been rather successful, it requires teachers' to have a very deep understanding of knowledge progression since repetition (even if at a different level) may cause students to become dissatisfied.

Pedagogy

Therefore, I have developed a 'statement of intent' which formulates the foundations in which the new course will be based on:

1.1 Whilst the course aims to develop the subject area you are specialising in, we also recognise, in practice, most science teachers have to teach across all three science subjects.

1.2 The Science Subject Knowledge Enhancement course has been upgraded into a more dynamic prequel to the PGCE course which you have chosen to undertake. It is our belief that teacher education must ensure that you understand the basics of subject knowledge for teaching at KS3 and KS4 (for your specialist subject), how pupils develop and learn, the role the science curriculum plays in teaching, the assessment of pupil progress as well as the necessary teaching skills required to be successful in the classroom.

1.3 The Science Enhancement Knowledge course will be organised in a way that will allow you to develop a mental map of what is involved in effective teaching and what factors influence student learning while enhancing your personal subject knowledge. It will allow you time try out new skills and methods which you will need in the classroom.

1.4 This mosaic of different learning domains lays the foundation for your lifelong learning as a teacher. Also, teacher preparation should be designed to help teachers learn from their practice and from the insight of others while you train. That is why you will engage in several microteaching sessions and peer-feedback. This will give you a hands-on experience of teaching while working on subject knowledge.

1.5 During the course we will make sure everyone has a basic grounding to enable them to teach Biology, Chemistry and Physics. The units in these subjects are designed to ensure adequate subject knowledge coverage for key stages 3 and 4. This grounding will also include experience in schools where you will observe science learning in action.

This had led me to develop a more

'democratic orientation to curriculum development [which must] involve[] reflection on the forces affecting societies and relationships in order not only to understand change but to be able to facilitate it. In reality, however, there are constraints in applying changes and managing the transition from a traditional, disciplinary, content-orientated curriculum that has 'steered the construction of educational practice for decades' to a more social and emancipatory model (Tiana, Moya, and Luengo 2011, 309)' (Byrne, Downe and Souza 2012, 3)

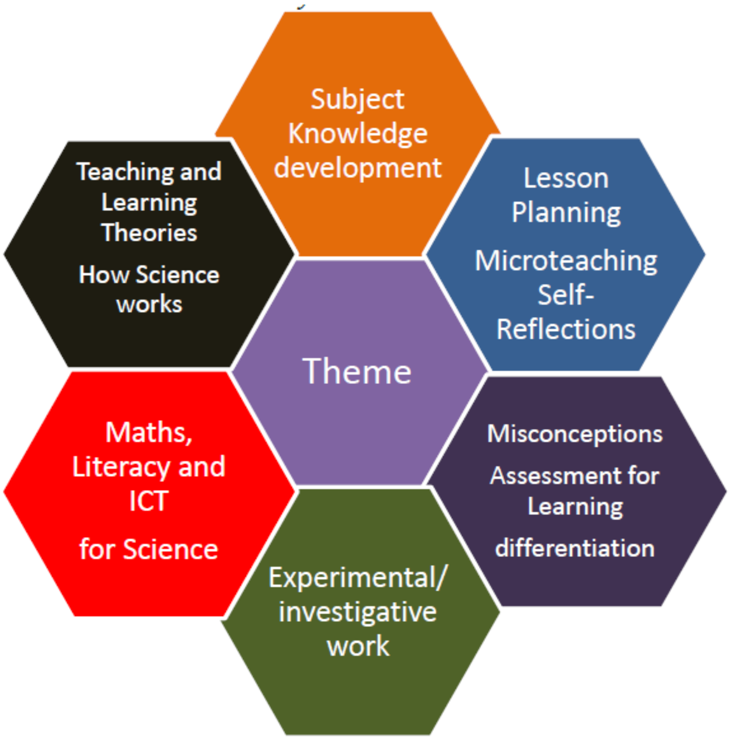
These constraints are sometimes socio-cultural-educational or political in nature. However, the Chemistry SKE is, at the moment, free from such demands as it does not have an external evaluation, external assessment or validation. It is a course funded by the old TDA (Teaching and Development Agency) without any ties to the Department for Education (although, this is likely to change in the future). Hence, the curriculum designer is has relatively free range in the decision-making process.

As the course leader and the curriculum developer, my philosophical and epistemological underpinnings definitely influence my process. However, I am bound by my professionalism which will certainly define the boundaries I will work in. The works of Paulo Freire (1994), Henry Giroux (1983) developed my awareness of critical pedagogy and its implementation in classrooms while Michael Apple (2004) has deeply influenced my educational philosophy in search for a more democratic approach to teaching and learning in order to 'release' ideological constraints which may be embedded in the normal and the hidden curriculum.

Vygotsky, Bloom and Ausubel's work shaped my pedagogical practice and therefore the construction of learning episodes. Bloom's cognitive learning taxonomy (1956) enables teachers to build on Vygostky social-constructivist approach to teaching and learning (1978) support Ausubel's ideas on how to promote meaningful learning constructs and through the development of viable subsunsors (1968). Meanwhile, the works of Paul Feyerabend, Karl Popper, Thomas Khun and Gaston Bachelard have played a crucial role in my epistemological understanding of science and science teaching. Feyerabend's anarchic view of science illuminates the infinite possibilities of teaching science and the conflicts between Popperian and Kuhnian science contribute to the construction of boundaries; and Bachelard's conception of progress through errors helps to demystify science teaching as being fixed in time (i.e. Chalmers 1999).

Curriculum design

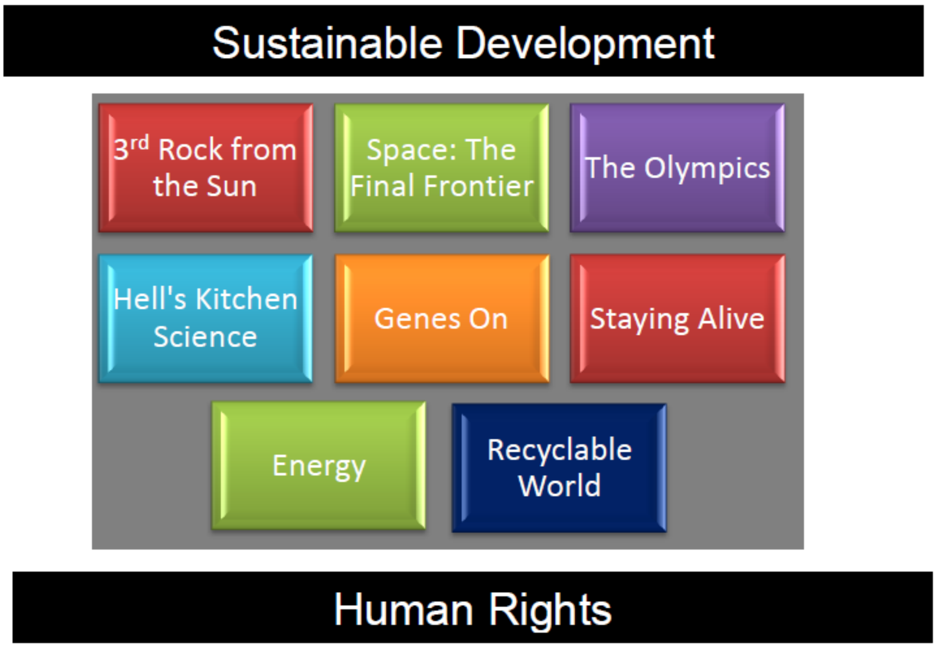
The amalgamation of such a variety of ideas has encouraged me to look beyond the realms of traditional curriculum development, seeking a non-linear approach within a thematic framework. The themes form the central tenets of the work. Each theme relates to the reality of the students or the world we are currently immersed. Meanwhile, within the themes, the sequence of events is likely not to be pre-determined. The only restriction is the actual content knowledge required at KS3 and KS4 Science. The overall thematic structure looks like this:



Thus, a multi-layered and thematic approach to the design of this new curriculum is used in order to develop learning episodes which allow student-teachers to fully engage with current scientific understanding and context that will support not only their subject knowledge but also their pedagogical content knowledge providing them with a more solid foundation for their PGCE year. Each of those strands encompass the range of knowledge and skills required by student-teachers in order to fully engage with the current needs of student-teachers during their PGCE-year as well as their NQT year.

Course Implementation

The course ran for a period of 25 weeks between January and July 2013 ; it was taught by myself as the course leader and a colleague who teachers science part-time at an inner London school. The structure of the course was as follows:



Each topic was based around a big idea/question which guided teaching and learning within the classroom. "The Olympics" for example, focused on new materials, metals and alloys and other related topics. "Genes On" focused on the Biology topics students would need to support student learning in Genetics as well as the Ethical aspects of Genetic Engineering. Sustainable Development and Human Rights were overarching topics and embedded within the themes when possible in order to illustrate particular issues that are relevant to our society.

The assessment was carried out throughout the year with periodic checks of students' teaching and learning log. In this log students had to reflect on the topics that were being studied and *"how"* this topic could be taught at school for different age groups. They needed to reflect on the issues that could arise due to misconceptions, lack of mathematical ability, health and safety due to practical work, etc. The focus was to engage students in their thinking about what teaching in a secondary school should look like and how they could promote student engagement.

The students had two school experience placements. The first placement was a 3-week period where they observed a variety of teaching and learning episodes from a variety of teachers. Each student-teacher was placed in a different school and had their own school experience log book. Furthermore, their second placement happened towards the end of the course over a period of 2-days a week over a 4-week period. This happened in the same school and this time the student-teachers had to team-teach two lessons each to the same class. This also meant that the other student-teachers were observing and supporting the lesson. This allowed them to develop an understanding of how their training is progressing, allowing them to provide feedback to each other as well as develop their subject knowledge.

In our understanding, these were crucial stages within the SKE course which we worked hard to promote its importance to our students. Their written reflection on these experiences was invaluable when assessing their progress against the aims of the course and demonstrated their commitment to teaching and learning. Additionally, their final misconception essay supported the development of their subject knowledge and has been used both as a formative and a summative assessment of the course. In the next session the official evaluation of the course will be briefly stated and commented on.

Course Evaluation

The official final course evaluation came from the report written by the external examiner for the Science PGCE/SKE at London Met. Among the final comments made were the following:

"The subject year (SKE) has been changed completely for the academic year 2012-13. The course is assessed through the collation of a teaching and learning log which develops throughout the year. This acts as a portfolio of evidence for all the taught sessions, subject knowledge audit and developmental actions, experiences in school (3 week placement, end of year days in school), enrichment activities (learning outside the classroom etc).

The logs I sampled provided very good evidence for students' making progress in their subject knowledge for school chemistry (physics and some biology) acquisition, as well as early confidence in pedagogical issues related to teaching ideas and skills in school. For example, support for learners during practical work was modelled using writing frames; there were many examples of creative ways of learning information and ideas in science which the students clearly valued throughout the course.

Students' subject knowledge was also assessed using various examination papers at stages during the year and finally an assessment of students' own pre-course misconceptions will be carried out at the end. The new Science Subject Leader redesigned the subject year (SKE) course following continuing feedback from previous student teachers about its relevance in preparing them for the Professional Year. The original University subject based *modules (biology/ physics for non-specialists, maths for chemistry etc) have been replaced with a series of subject (chemistry, physics and some biology) and pedagogical knowledge sessions throughout the year.*

I observed a short physics session in May in which trainees were actively exploring the nature of light and all those I spoke with valued these subject sessions very highly. The ideas and expertise brought to the sessions by the Science Subject Leader was valued very highly. The three-week school placement was also cited as a very important factor in developing confidence in the ability to stand in from of a group of young people and to begin to understand what effective teaching 'felt' like.

As the year continued, the subject leader continually looked to modify the students' experiences in the light of their feedback, and new opportunities which arose. For example, the students wanted more chemistry subject knowledge teaching at KS5, so the subject leader arranged for this. Towards the end of the course, another highlight for the students was the opportunity to work in a placement school for two days per week over a four week period, in the run up to the Professional Year – invaluable preparation"

Overall, I believe this describes in full the success of the course and the advantages of having developed a course of this nature, as well as demonstrating the benefiting which the students that have undertaken this SKE course have gained in teaching and learning.

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Biographical note

At the time of writing, Roussel De Carvalho, a former Head of Physics who moved into Initial Teacher Education in 2012, was the Course Leader for the PGCE Science programme in the Education subject area of the Faculty of Social Sciences and Humanities. In September 2013 he joined the Institute of Education (IOE) as a lecturer in Science Education.