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Response to the draft curriculum -
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Whole curriculum philosophy

The draft curriculum is an inspirational document. Putting the needs of the learner first and building upwards is at the same time a radical and common-sense approach. The general information in the book is extremely well-written and provides a brilliant distillation of the wisdom of educators for the times in which we live. The pages on curriculum design, pedagogy and assessment have already proved extremely useful to me as a Head of Faculty in designing and developing our curriculum.

As a physics teacher and writer who worked on several teams for the *21st Century Science* project in England before moving to New Zealand (and having taught under several different types of curriculum structure in the UK and in the USA), I am thrilled to be working in New Zealand at a time when I can help to develop this exciting and world-leading curriculum. The comments below are intended to be supportive and to help to iron out the wrinkles and potential pit-falls, rather than to be anything against the curriculum per se.

Achievement Aims of Science

There is a mismatch between the aims of the different stands of science - Physical World is divided into inquiry, concepts and application, whereas the other subjects focus on themes within the concepts.

None of the subjects is easy to define. When I worked at the Institute of Physics in London it was a standing joke that physicists around the world had many common goals and aims, but the one thing they could not agree on what "physics" *is*! In New Zealand also it seems pointless to spend too much time worrying about the precise definition of each of the traditional categories of Science. The boundaries between subjects have never been clear, and the Science of the 21st century (biophyiscs, materials science, nanotechnology, genetic engineering and so forth) makes the arbitrary classifications even less meaningful. The only reason I can think of for defining each subject Chemistry (aka Material World) etc. is so that we know *why* we are teaching it. We need to be sure what arewe aiming to do for our students by teaching them these ideas.

The subjects we teach at school are at present very different to those taught at university level. For example the classification taught in biology is based on what an organism looks like, whereas at university level organisms are classified according to their d.n.a.; school physics totally ignores quantum theory - the most important development in physics in the last 100 years, which has led to the development of mass-communications and the information age. So we have to keep asking "what is the point of teaching it?"

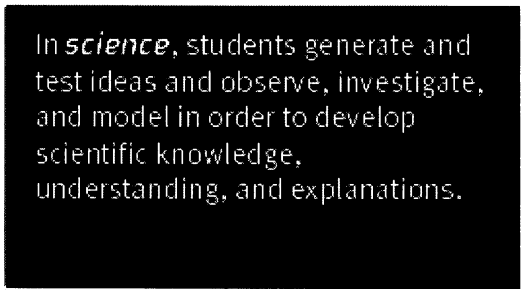
The Achievement aims then are surely to guide teachers so they are aware of why we think that Science and these subjects in particular, should be in the National Curriculum. I would like to see this flagged up more clearly.

I am concerned that Physics is the only subject to mention enquiry as an important strand. Scientific enquiry (as flagged in the Investigating section) should be taught in all four strands and it is not special to Physics - so why does Physical World give it a special mention? The danger is that the other strands leave the investigating to Physics!

It would seem that each of the strands had a different committee, who approached the writing with slightly different philosophies. They were then asked to condense their ideas into three themes. It seems to have worked well for the Living World (if we agree that Humans don't have a special place!) but in the other sections it works less well. Is there any reason that each strand should have three bullet points? I can see that we would want each strand to have an equal weighting, and therefore to have similar amounts of text, but why three bullet points?

In the Planet Earth and Beyond Section, the 'interactions' is very vague, and to suggest that everything important that happens can be cyclic is odd – there are different theories about the Universe, but it could be that there is only one Big Bang and that our Universe has one beginning and will maybe have one end. No cycle there then! So why pin it down to interacting cycles? A nice theme, but is it really what we are trying to teach??

In the Physical World the ideas are intentionally vague – fine if all the other strands are doing the same, but here looking as the Physics teachers just didn't know what to do!



On page 13 science is described as if students were to develop their own scientific knowledge. The reality is that most scientific knowledge has to be learned: teachers can (and should) be encouraged to try to contrive situations in which students realise and come to understand fundamental concepts, by giving the students exciting and challenging tasks, but it should be clear that we can only progress in science by 'standing on the shoulders of Giants' to quote Isaac Newton. On page 13 the curriculum is at least suggesting a type of pedagogy that is lamentably rare in our schools. To even begin to make the acquisition of science learning student focussed is a very very tough task!

How does Science relate to other disciplines?

There is lots of overlap and potentially rich learning opportunities in the common ground between subject. I think these should be flagged up more clearly with various models for delivery of these subjects made clear. For example I meet Science teachers who are complaining bitterly that 'Health has got all the interesting human biology now, but they (i.e. Health teachers) won't do it properly...' I have no interest in feuding over important knowledge between faculties, but it cannot be denied that scientific facts, blood guts and all, probably involving science teachers and laboratories, make a very important input into hitting home messages about safe sex, smoking etc. The same can be said of environmental issues which sit between Science and Social Science, and numeracy and literacy skills which are being taught by science teachers.

Can we define content by levels?

There has been a lot of discussion between teachers about the level of detail in the content of this draft. Most teachers have criticized the document for its lack of detail. I started actually trying to write a curriculum which fits the document for our Year 9 Science students and I realized that the document as it stands is internally inconsistent. According to the chart on page 34 students in Year 9 may be working at levels between 3 and 7. This is only to be expected, since they have very different abilities and backgrounds. So how do you write a curriculum for a Year 9 class to accommodate their learning needs? To assume that they are all at level 5 (as I have heard people suggest) clearly goes against the philosophy of the draft curriculum - we must not ignore the students who are working at higher or lower levels .

When I came to write learning outcomes for the topics we are teaching the detail in the Achievement aims was great for some areas, but seemingly impossible to manage in others. For example in the Physical world I can conceive of having a class in which students are looking at making a circuit to light a lamp. Those at level 3 can be expected to understand that the battery is providing electricity to the lamp (using a scientific idea - electricity); at level 5 could identify concepts of a complete circuit, current and voltage from the battery to push the current, at level 6 could solve problems relating to circuits, design their own circuits to suit different purposes etc. And any level 7 workers could be challenged to identify relationships between voltage and current etc.
However, for 'astronomical cycles' it is difficult to conceive of a whole class learning at the levels specified without running individual programmes for each child. Are they making observations of the Sun, Moon and Earth or studying the distances in the solar system? Wherever the levels of a strand are content-specific the teaching of a multi-level group becomes unworkable.

Are we confusing conceptual development with exposure to content? Which are we mandating by matching curriculum with levels? This needs to be clear.

Content and conceptual development are not the same. It is quite common to meet students who have 'done' the planets of the solar system, yet have no idea of the vastness of space. Students may recite Newton's Laws and $E=mc^2$ but that doesn't mean they have learned the concepts, but they have 'done' the subjects. The draft curriculum supports the move away from learning facts and concentrates on skills and conceptual development. This is great, but the content must still be there, but how and where?

Specific science content (and specific learning objectives) needs to be separated from the conceptual development of the students that we are really looking for by developing this curriculum. I was initially confused at the lack of content, but I now feel that mandating it in too much detail in this document is to miss the point of the curriculum. But what we desperately need is a second tier Science document which does mandate the content. That said there will always be a danger that teachers only look at the content and forget about the real achievement aims.

We have to be realisitic and see that students can either be

1. taught as they are now in same-age groups (roughly), with a wide range of levels of conceptual development within the group
2. taught according to achievement level
3. given individualized schemes.

In order to develop the other, wider aims of the curriculum, options 2 and 3 are really only suitable as a last resort and we have to have a system that can cope with students who are at different levels in the same class, studying the same topic.

I now feel very strongly that the national curriculum for science should have define generalized conceptual content defined with a very well reasoned and yet flexible second tier for the science curriculum.

Second Tier Content Should be defined by school Year

Science skills and concepts are developed by exciting students as they encounter various aspects of Science - cells and microscopes, electricity, making hydrogen..... They will continue to perceive that this is the lesson they are learning. We can try to teach metacognition and help them to realise that they can look up the receipe for making hydrogen on the internet - that the real lesson is about chemical change, and about the nature of gases etc. The extremely important point to recognise is that students need to be exposed to a wide range of different and relevant science content. If a student has 'done' electricity at Intermediate, it will be impossible to motivate and inspire them in quite the same way as if they met something new and different (maybe electromagnets next, or springs and forces....).
I therefore believe that coupled with a revision of the current draft we must have a clearly defined list of topics by year group, not ability level.

The secondary science teachers I talk with are all frustrated already by the wide range of experiences of Science their new-entrants bring. In a Year 10 Science class this week I had 10/24 students who had 'done' the solar system - some of them had done it twice, but 14 had never been taught in school about the planets. The current curriculum clearly says that by Year 10 students should have been taught something about the planets. The lack of consistency in the implementation of the current system creates a lot of problems in schools - particularly in our school with over 60 feeder schools. If we do not make content absolutely clear, then I fear that we will have a free-for-all, and students will be in real danger of doing some topics four or five times but doing some topics not ever.

Curriculum delivery needs to be supported with resources

Providing a list of topics for each year level is not enough. Teachers will simply see 'electricity in Year 10' and go back to doing what they have been doing for the last 20 years. If we are to really make the leap into teaching relevant science, integrating the Nature of Science ideas into a rich curriculum, teachers need more help and support. The 21st century Science course, launched in Britain in 2006, was put together over a course of five years and involved hundreds of writers, thousands of teachers and tens of thousands of students. The impact has been massive because it not only started with sound rationale, but it finished with schemes of work, text books (at two levels), DVDs, professional development courses and a nationally-validated assessment. Here in New Zealand it is not enough to expect teachers to be able to deliver to the same vision without giving them adequate resources.

Having worked on 21st century Science, I would love to see a deal be brokered with the copyright owners and with some of the key developers so that we can develop something similar, but something which is entirely NZ appropriate and NZ-focussed. There are many other inspirational schemes in the rest of the world too, and we should be giving a team of teacher-authors time and money to go out and write texts and resources for teachers. Unless training and resources are provided, the great ideas represented in this draft curriculum articulates will be watered down and change nothing.