Parents and Teachers for Excellence Research Note

September 2016

Why we need a knowledge-based curriculum

- **Primary and secondary schools across the country should be shifting to a knowledge-based curriculum.**
- **Evidence from cognitive science and studies of different schools show that a knowledge-based curriculum is the most effective. It is also, taught properly, interesting and enjoyable for students.**
- **A knowledge-based curriculum is particularly important for pupils from disadvantaged backgrounds.**
- **Parents can help by giving their children books on non-fiction subjects that fascinate them – from dinosaurs to space to ancient Egypt – and encouraging them in their interest.**

We all want students to emerge from school as curious, creative people with the ability to analyse the world around them and contribute to our society. But how do we get there?

This note argues that a knowledge-based curriculum is best for producing well-educated, creative people who can thrive in the 21st century, and is also a good way of keeping students interested and engaged.

By a knowledge-based curriculum we mean two things:

- The curriculum should have strong, formal foundations in traditional subjects.
- The curriculum should be structured carefully so that students are building on what they already know.

This is a counterintuitive argument – that such a "traditional" seeming approach is the best way to instil creativity and stimulate students.

This note aims to explain that argument further.

Moving from early years to school

The need for a knowledge-based curriculum is not obvious, because it goes against much of our experience as parents of pre-school children. But the subjects in school are very different from early developmental skills of movement and language.

- When children are very young – before they go to school - parents are given simple guidelines. For their physical development, they are told to give them a safe space to explore. For language, they are told to talk to them using a range of vocabulary - and allow them to talk back. For social development, parents are told to engage with children and model good behaviour. It is a process of inquiry and discovery led substantially by the child. We do not have a list of 100 words we go through methodically with a baby, with a test every other week.

- But these early skills are substantially innate. Children are born with the ability and desire to learn language and form emotional and social connections. The best way we help them is to encourage their discovery and give them reassurance.
- Even then, it takes thousands of hours of patience and repetition before children learn. And as adults we are doing more teaching than we realise. We adjust our responses to the child, so that they understand as much as possible. The cognitive scientist Dan Willingham has given a good example; if an adult asked what he was eating he might say, "it's Westphalian ham on brioche." If a toddler asked, he would say "It's a sandwich."[1]
- Formal education requires a much more deliberate, knowledge based curriculum than early development for two reasons. First, it is *not* innate. The alphabet and written language is a recent (in evolutionary terms) human invention. So is the language of mathematics. The parts of the brain that absorb this information, and how, are very different from early childhood skills. You cannot rely on natural discovery in the same way. We cannot expect children to learn about gravity, calculus, or evolution by wandering around and talking to those they meet. You have to impart the ideas to them, consistently and over a long period of time.
- Second, the subjects in formal education are cumulative. Most subjects rest on two cores – reading and writing, and numeracy. Without them, you cannot learn anything else. And within each subject, new ideas rest on the understanding of earlier ones.

This means that when children enter school they not only need to be exposed, deliberately, to new knowledge, but that the school should carefully structure that knowledge so that students are building on prior foundations.

<u>The cognitive science behind knowledge</u>

In recent decades, advances in our understanding of the human brain have confirmed the need for a knowledge-based curriculum for two reasons:

1. Knowledge frees up your brain's capacity for thinking

Cognitive scientists have found that our brain works at different speeds, depending on whether we have learned something already, or whether we are relying on "working memory". Working memory is new information you can keep in your head. It is very limited – you can hold between three and seven pieces of new information - and it is tiring keeping things in your working memory.

That is why learning your times tables by heart is useful. Imagine you are given the following problem: "2*2+2*3+6*8=x". The problem is hardest if you do not know what ***,** +, and **=** mean, and the order of mathematical operations. This is knowledge. But the problem is also harder if you have to work out in your head, from scratch, what 2*2 is and what 6*8 is. If you know your times table, you will automatically see that this problem is "4+6+48". It is much quicker and easier to work out the answer – you probably do not even need to write anything down.

2. We learn new things by connecting them to old things

[1] For the article see http://www.danielwillingham.com/daniel-willingham-science-and-education-blog/what-type-of-learning-is-most-natural

The way in which the brain stores new information, and makes inferences and discoveries, is by connecting to existing stored knowledge. You cannot have skills without knowledge, because you cannot evaluate something you do not know anything about. You also cannot come up with new ideas without jumping off existing ones: Einstein could not have discovered relativity if Newton had not already come up with gravity - and if someone had not taught Einstein about Newton's discovery. And Newton could not have come up with gravity without the inventions of many who came before him: that is why he said he was "standing on the shoulders of giants". Newton and Einstein were among the most creative people in history: creativity requires knowledge.

The transferability of knowledge and skills

A lot of people in schools think that knowledge is less important than "skills". They usually mean one of two things:

- Subjects have specific skills, and it is more important to learn those skills than the content. For example, you should learn how to generate a hypothesis and test it. Or you should learn how to compare and contrast. Once you have those skills, you can apply them to any example.
    - The problem is that to do either of these well, you need a lot of knowledge. For example, if you need to compare and contrast the merits of two different constitutions, you need to understand terms such as parliament, constitution, government, and law. To understand those terms, you need to be able to draw on examples – the UK parliament, the US constitution, what governments across the world do. In other words, you need knowledge: it is the *knowledge,* as well as the skill, that is transferable. If you want students to be skilled, then you need to impart a lot of knowledge first.
- That as long as you learn important general skills – like thinking critically or being imaginative – you can look up the relevant facts when you need to. There are two problems with this:
    - The first is that skills like "thinking critically" are not really transferable.
      For example, imagine you are a chess master who has never studied biology. A chess master has astonishing analytical skills, but dump him in a lab and he will not be able to cure cancer. He will need a lot of understanding of biology before he can apply those skills.
      Here is another example from well-known cognitive scientist Daniel Willingham: "Imagine you know that car A gets better gas mileage than car B and you'd like to know why. This is a classic analysis problem. There are many differences between the cars, so which will you investigate first? Engine size? Tire pressure? A key determinant of the hypothesis you select is plausibility, or you are likely to spend a very long time finding the answer. You won't choose to investigate a difference between cars A and B that you think is unlikely to contribute to gas mileage (e.g., paint color), but if someone provides a reason to make this factor more plausible (e.g., the way your teenage son's driving habits changed after he painted his car red), you are more likely to say that this now-plausible factor should be investigated. One's judgment about the plausibility of a factor being important is based on one's knowledge of the domain."

- The second problem is that, as explained above, "looking up" new information is exhausting. It uses up your brain's capacity, reducing its ability to think.

This is why you cannot just "google the answer" in the Internet age. Without knowing quite a lot about what you are looking for, and without being able to draw on knowledge to evaluate what you find, it is very difficult to figure out answers from the Internet. In fact, in a very fast moving world which is based on virtually free communication and data, broad background knowledge is *more* important not less. Without it, you cannot hope to process what you see or understand new discoveries.

Teaching a knowledge-based curriculum

It is not only the content that matters but how you teach it. With high quality instruction:

- What students are taught should be explicitly linked to what they already know. You cannot teach multiplication if students do not understand numbers. You cannot teach evolution if students do not know what a species is.
- It matters if students remember what they learn. For example, if a student is given an article about World War II, and there is a reference to importance of the Treaty of Versailles that they discussed the previous term, then the students should know what is being discussed and why it is relevant.
- It matters what students are paying attention to. People learn what they concentrate on. For example, you could teach Romeo and Juliet by a) watching the play and discussing the language that is used; or b) making a puppet theatre to perform Romeo and Juliet. The second sounds fun, but in ten hours students will have spent a lot of their time concentrating on cutting out puppets. Because that is what they are concentrating on, that is what they will remember. This is not efficient, unless what you meant to do was teach children to be puppet makers.
- This might seem obvious, but the puppet example is very common in schools and it is not setting children up well for the future. In the top schools in the country, and in the best education systems in the world, students are not learning this way.
- The irony is that while teachers often try to find complex ways of interesting students in content because they assume it is too difficult or abstract, the content itself is fascinating. Think about how excited children get when they learn *everything there is to know* about dinosaurs, or football players. The number of facts they learn and want to share can feel never-ending. A good school teaching knowledge inspires the same excitement, because children like to feel they are learning and doing well – and when they can apply their knowledge to the next challenge, there is an enormous sense of accomplishment. The great thing about knowledge is that with every new fact you learn, the number of new ideas and connections open to you increases enormously.
- A number of studies[2] have shown that "direct instruction" is particularly effective. In direct instruction teacher deliberately *teaches* the students, rather than leaving it up to them to discover the answer. Students only progress to the next concept when they have mastered the previous one, and they practice a lot to make sure they understand what they have been

[2] e.g. Adams, G, and Engelmann, S (1996); Borman, G.D et al. (2003); National Reading Panel (2000)

taught (this is also how people learn to play musical instruments well). There is a constant dialogue between the teacher and students in the form of questions and answers, so that the students do not switch off and the teacher knows if they are being understood.

This combination – learning the right things, in the right way through direct instruction – would enormously boost standards in our school.

Who does a knowledge-based curriculum help most?

- A number of studies[3] have shown that disadvantaged students benefit most from a knowledge based curriculum, because they have not been exposed to the range of vocabularies and ideas outside school as some of their wealthier peers. If you grow up in an academic family, with a house full of books that your parents discuss with you every day, you will absorb a *lot* of facts. If you do not, you will not have the same opportunity. That is why school needs to impart knowledge systematically.
- This is particularly important in reading. One famous study showed that "poor readers" did better than "good readers" when the poor readers knew about the subject of the text (in this case baseball), and the good readers did not.
- If you think about the cognitive science, this makes sense. You can learn how to decode new words (this is what phonics teaches you) but without learning vocabulary, it is of limited use.
- That is why it is difficult to "look up online" new knowledge or words without already having a very wide vocabulary. When you come across a new word – "exesquiggle" for example - you can have a go at reading it and pronouncing it. And you can look it up in a dictionary: "exesquiggle is the insanguination process by which elemantines disavolve their young".
- The sentence above is nonsense, of course. But if you do not have a good vocabulary, a lot of the sentences you read will feel like nonsense. Because there are many words in the sentence you do not know the meaning of, you cannot figure out what exesquiggle means. This is what happens every day to people who try to read a broadsheet newspaper, but were not given a good knowledge-based education. The sentences are so full of references and words they do not know, they cannot understand what is being said. And if they try and look up words in a dictionary that is a) very slow, inefficient, and frustrating; and b) the definition will also contain words they don't know! They're likely to give up and throw the newspaper across the room: which is exactly what happens to a lot of students in class. They have not been taught enough to understand the new material, so they get frustrated and disengage.

[3] Please see this page for detail of studies www.coreknowledge.org/research