CRACKING KEY CONCEPTS *in* SECONDARY SCIENCE

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INTRODUCTION

'If you can't explain it simply you don't understand it well enough'.

Whether or not Albert Einstein ever said the above has not stopped it becoming a well-loved internet meme, and there are probably few science departments in the country without a glossy poster featuring it imposed on a suitably science-y background. For us, the interesting thing is not whether Einstein ever said it, but whether it is true.

We are most certainly believers in the importance of subject knowledge in crafting powerful science explanations, and it's almost trivially correct that if you don't understand something you can't explain it to another. Understanding is most definitely a *necessary* condition for explaining. But is it a *sufficient* condition? If a person understands something fully, does that mean they possess all they need in order to explain it simply? We think the quote infers this, and we strongly reject it as a proposition. Subject knowledge gets you part of the way, but there is a distinct set of skills and knowledge required before a challenging topic can be explained.

For many years, it seems that teacher explanation has been taken for granted. In a nation-wide focus on pedagogy, activity, student-led learning and social constructivism, the role of the teacher in taking challenging material and explaining it has been de-emphasised, with discovery, enquiry, peer-to-peer tuition and 'figuring things out for yourself' becoming ascendant. Not only that, but a significant number of influential organisations and individuals championed the cause of 'talk-less teaching' where the teacher was relegated to a near-voiceless 'guide on the side', sometimes enforced by observers with a stopwatch and an inflexible 'teacher talk' time limit.

We earnestly hope that such egregious excesses are now a thing of the past; but we must admit that all too often, the mistakes engendered by well-meaning edu-initiatives live on, while whatever good they achieved lies composting with the CPD packs from ancient training days. Even if they are a thing of the past, there has been a collective deskilling when it comes to the crafting of a science explanation – there is little institutional wisdom and few, if any, resources for teachers to use as a reference.

It is in light of the above that this book has been written. We strongly believe that the central part of any science lesson or learning sequence is a well-crafted and executed explanation. But we are also aware that many – if not most – teachers have had very little training in how to actually go about crafting or executing their explanations. As advocates of evidence-informed teaching, we hope to bring a new perspective and set of skills to your teaching and empower you to take your place in the classroom as the imparter of knowledge.

We do, however, wish to put paid to the suspicion that we advocate science lessons to be *all* chalk and talk: we strongly urge that teachers should use targeted and interactive questioning, model answers, practical work, guided practice and supported individual student practice in tandem with ‘teacher talk’. There is a time when the teacher should be a ‘guide on the side’ but the main focus of this book is to enable you to shine when you are called to be a science ‘sage on the stage’.

This book will begin with an opening chapter dealing with the nuts and bolts of high-quality science explanations. The rest of the book takes key topics from 11–16 science and shows you how to explain them. The explanations will explicitly draw on techniques which are advocated in the opening chapter, and will essentially serve as worked examples of the skills we are hoping to impart.

We do make claims to being evidence-informed, but we will not be providing a citation for every statement made. Our practice is informed by evidence, but also mediated and filtered by experience in the classroom. There are no randomised controlled trials for how best to explain rates of reaction or the lock and key model. We commit to making clear how the research has informed our practices, but also make no pretence as to being definitive. Rather than being the last word, we hope that this book is the first word in helping you to tailor, adapt and craft your own explanations. In a similar vein, this is not a comprehensive book covering the entire gamut of science education. Expert science instruction relies on many factors that lie beyond our scope, which only focuses on one narrow aspect of a greater whole.

We hope that you find this book enjoyable, thought-provoking and helpful but most importantly we hope that you find it to be empowering.

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