

Cambridge University Press  
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Excerpt  
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# Introduction to the series by the editors

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## Approaches to learning and teaching Science

This series of books is the result of close collaboration between Cambridge University Press and Cambridge International, both departments of the University of Cambridge. The books are intended as a companion guide for teachers, to supplement your learning and provide you with extra resources for the lessons you are planning. Their focus is deliberately not syllabus-specific, although occasional reference has been made to programmes and qualifications. We want to invite you to set aside for a while assessment objectives and grading, and take the opportunity instead to look in more depth at how you teach your subject and how you motivate and engage with your students.

The themes presented in these books are informed by evidence-based research into what works to improve students' learning and pedagogical best practices. To ensure that these books are first and foremost practical resources, we have chosen not to include too many academic references, but we have provided some suggestions for further reading.

We have further enhanced the books by asking the authors to create accompanying lesson ideas. These are described in the text and can be found in a dedicated space online. We hope the books will become a dynamic and valid representation of what is happening now in learning and teaching in the context in which you work.

Our organisations also offer a wide range of professional development opportunities for teachers. These range from syllabus- and topic-specific workshops and large-scale conferences to suites of accredited qualifications for teachers and school leaders. Our aim is to provide you with valuable support, to build communities and networks, and to help you both enrich your own teaching methodology and evaluate its impact on your students.

Each of the books in this series follows a similar structure. In the first chapter, we have asked our authors to consider the essential elements of their subject, the main concepts that might be covered in a school curriculum, and why these are important. The next chapter gives you a brief guide on how to interpret a syllabus or subject guide, and how to plan a programme of study. The authors will encourage you to think too about what is not contained in a syllabus and how you can pass on your own passion for the subject you teach.

## Introduction to the series by the editors

The main body of the text takes you through those aspects of learning and teaching which are widely recognised as important. We would like to stress that there is no single recipe for excellent teaching, and that different schools, operating in different countries and cultures, will have strong traditions that should be respected. There is a growing consensus, however, about some important practices and approaches that need to be adopted if students are going to fulfil their potential and be prepared for modern life.

In the common introduction to each of these chapters we look at what the research says and the benefits and challenges of particular approaches. Each author then focuses on how to translate theory into practice in the context of their subject, offering practical lesson ideas and teacher tips. These chapters are not mutually exclusive but can be read independently of each other and in whichever order suits you best. They form a coherent whole but are presented in such a way that you can dip into the book when and where it is most convenient for you to do so.

The final two chapters are common to all the books in this series and are not written by the subject authors. Schools and educational organisations are increasingly interested in the impact that classroom practice has on student outcomes. We have therefore included an exploration of this topic and some practical advice on how to evaluate the success of the learning opportunities you are providing for your students. The book then closes with some guidance on how to reflect on your teaching and some avenues you might explore to develop your own professional learning.

We hope you find these books accessible and useful. We have tried to make them conversational in tone so you feel we are sharing good practice rather than directing it. Above all, we hope that the books will inspire you and enable you to think in more depth about how you teach and how your students learn.

Paul Ellis and Lauren Harris

Series Editors

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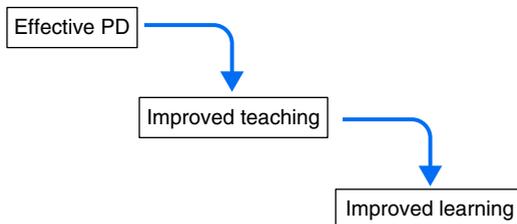
## Purpose and context

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International research into educational effectiveness tells us that student achievement is influenced most by what teachers do in classrooms. In a world of rankings and league tables we tend to notice performance, not preparation, yet the product of education is more than just examinations and certification. Education is also about the formation of effective learning habits that are crucial for success within and beyond the taught curriculum.

The purpose of this series of books is to inspire you as a teacher to reflect on your practice, try new approaches and better understand how to help your students learn. We aim to help you develop your teaching so that your students are prepared for the next level of their education as well as life in the modern world.

This book will encourage you to examine the processes of learning and teaching, not just the outcomes. We will explore a variety of teaching strategies to enable you to select which is most appropriate for your students and the context in which you teach. When you are making your choice, involve your students: all the ideas presented in this book will work best if you engage your students, listen to what they have to say, and consistently evaluate their needs.



Cognitive psychologists, coaches and sports writers have noted how the aggregation of small changes can lead to success at the highest level. As teachers, we can help our students make marginal gains by guiding them in their learning, encouraging them to think and talk about how they are learning, and giving them the tools to monitor their success. If you take care of the learning, the performance will take care of itself.

When approaching an activity for the first time, or revisiting an area of learning, ask yourself if your students know how to:

- Approach a new task and plan which strategies they will use
- Monitor their progress and adapt their approach if necessary
- Look back and reflect on how well they did and what they might do differently next time.

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## Approaches to learning and teaching Science

Effective learners understand that learning is an active process. We need to challenge and stretch our students and enable them to interrogate, analyse and evaluate what they see and hear. Consider whether your students:

- Challenge assumptions and ask questions
- Try new ideas and take intellectual risks
- Devise strategies to overcome any barriers to their learning that they encounter.

As we discuss in the chapters on **Active learning** and **Metacognition**, it is our role as teachers to encourage these practices with our students so that they become established routines. We can help students review their own progress as well as getting a snapshot ourselves of how far they are progressing by using some of the methods we explore in the chapter on **Assessment for Learning**.

Students often view the subject lessons they are attending as separate from each other, but they can gain a great deal if we encourage them to take a more holistic appreciation of what they are learning. This requires not only understanding how various concepts in a subject fit together, but also how to make connections between different areas of knowledge and how to transfer skills from one discipline to another. As our students successfully integrate disciplinary knowledge, they are better able to solve complex problems, generate new ideas and interpret the world around them.

In order for students to construct an understanding of the world and their significance in it, we need to lead students into thinking habitually about why a topic is important on a personal, local and global scale. Do they realise the implications of what they are learning and what they do with their knowledge and skills, not only for themselves but also for their neighbours and the wider world? To what extent can they recognise and express their own perspective as well as the perspectives of others? We will consider how to foster local and global awareness, as well as personal and social responsibility, in the chapter on **Global thinking**.

As part of the learning process, some students will discover barriers to their learning: we need to recognise these and help students to overcome them. Even students who regularly meet success face their own challenges. We have all experienced barriers to our own learning at some point in our lives and should be able as teachers to empathise and share our own methods for dealing with these. In the

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chapter on **Inclusive education** we discuss how to make learning accessible for everyone and how to ensure that all students receive the instruction and support they need to succeed as learners.

Some students are learning through the medium of English when it is not their first language, while others may struggle to understand subject jargon even if they might otherwise appear fluent. For all students, whether they are learning through their first language or an additional language, language is a vehicle for learning. It is through language that students access the content of the lesson and communicate their ideas. So, as teachers, it is our responsibility to make sure that language isn't a barrier to learning. In the chapter on **Language awareness** we look at how teachers can pay closer attention to language to ensure that all students can access the content of a lesson.

Alongside a greater understanding of what works in education and why, we as teachers can also seek to improve how we teach and expand the tools we have at our disposal. For this reason, we have included a chapter in this book on **Teaching with digital technologies**, discussing what this means for our classrooms and for us as teachers. Institutes of higher education and employers want to work with students who are effective communicators and who are information literate. Technology brings both advantages and challenges and we invite you to reflect on how to use it appropriately.

This book has been written to help you think harder about the impact of your teaching on your students' learning. It is up to you to set an example for your students and to provide them with opportunities to celebrate success, learn from failure and, ultimately, to succeed.

We hope you will share what you gain from this book with other teachers and that you will be inspired by the ideas that are presented here. We hope that you will encourage your school leaders to foster a positive environment that allows both you and your students to meet with success and to learn from mistakes when success is not immediate. We hope too that this book can help in the creation and continuation of a culture where learning and teaching are valued and through which we can discover together what works best for each and every one of our students.

# 3

## The nature of the subject

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## What is the place of Science in the curriculum?

It is easy to think of Science as a pre-formed collection of facts to be delivered to our students. However, even though there are curricular demands (they need to know stuff!), our students also need to know what Science is, and why we study it.

Learning Science should ensure that students realise the importance of evidence in making decisions and coming to conclusions, not just about scientific issues, but about social and ethical issues too.

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### Teacher Tip

Including ethical decision-making into learning activities in Science lessons can be very engaging for students. Try to frame a lesson around an ethical dilemma which students can only resolve after having learnt the relevant Science. For example, understanding pre-implantation genetic diagnosis can provide a framework for understanding inheritance.

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Unless students understand how scientific knowledge is generated, through critical evaluation of evidence, they really will be simply learning a set of pre-formed facts. Most Science teachers would uphold the principle of experimental and inquiry-based learning in Science, which provides that focus on evidence. It also cultivates skills such as observation, comparison, classification and prediction. It helps students to understand how to test ideas systematically, and how to seek and interpret evidence for scientific claims.

Are these skills necessarily superior to those taught by other subjects? Not really. But are they important in a world focused on scientific development, where science and technology are fundamental components of many economies? Yes, of course!

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### Teacher Tip

Discuss with teachers of History how they introduce inquiry and evidence in their lessons. Gaining perspectives from a different subject which also focuses on evidence can help you to think about your own practice in developing students' inquiry skills.

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However, Science has something more natural underpinning it. You can think of every child as a mini-scientist. They have spent their childhood trying to make sense of the world, drawing upon observations of natural phenomena. But that process isn't perfect, and may leave the children with misconceptions (sometimes known as alternative conceptions), even if such misconceptions may have a small amount of 'truth' within them!

For example, children may suggest that wrapping a blanket around a block of ice would make it melt quicker, because when the blanket is wrapped around their body, it feels warm. Likewise, when they are asked to draw arrows between an object and an eye, to help describe how sight happens, children will often draw arrows pointing towards the object. This idea of 'active eyes' makes sense to children, but having understood the Science, they would direct the arrows correctly, showing the passage of light from the object to the eye.

Replacing intuitive 'sense-making' with systematic 'sense-making' is one of the primary purposes of Science education, promoting systematic and critical thinking in your students.

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## What are some of the fundamental areas of knowledge in Science?

In many schools, and by many teachers, school Science tends to be thought of simply as a body of knowledge. If this is you, don't worry; you're not alone. You probably found Science fascinating as a child, and you simply want to pass on these fascinating ideas to your students.