

Reviews from the first edition

This is the book I have been waiting for. Ever since I first started working with teachers on preservice and inservice programs (US) and teacher training and inset courses (UK) in the 1980s, I wished there were a book that presented seminal studies in education and psychology in an accessible way, and drawing out implications for practice. This is it. In this wonderfully readable book, Bradley Busch and Edward Watson present 77 key studies from education and psychology, spanning over 60 years that every teacher should know about. Whether you are just beginning as a teacher, or a seasoned veteran, there will be something here that will be directly relevant to your practice and, perhaps more importantly, will make you think. Highly recommended.

Dylan Wiliam, Emeritus Professor of Educational Assessment, University College London, UK

This book will prove irresistible to anyone keen to understand more about essential educational research findings in the most accessible manner possible. The authors identify the most influential and important findings of research relating to key issues in classrooms such as effective teaching, student behaviours, the impact of family and practice that develops skilled learners. Busch and Watson offer a concise, punchy and engaging resource for everyone seeking to help children and young people learn in the most effective way. An absolute must for every school.

Professor Dame Alison Peacock, Chief Executive, The Chartered College of Teaching, UK

The Science of Learning is a timely and precious gift to teachers. We know that research and evidence, used well, are vital complements to teachers' experience and professional judgement, but finding the most relevant research, understanding what it shows, and knowing how to implement these findings accurately can be really tricky. No wonder that, despite the burgeoning interest in research among teachers, there is still limited application of research in teachers' practice. This book provides an appealing and trustworthy solution: a range of fascinating studies - from large-scale and replicated to small and quirky - has been selected and their findings summarised with brilliant clarity. The discussions are brief but nuanced, and the sections on "classroom implications" offer thoughtful suggestions about how this knowledge can inform teachers' practice. The explanations are simple but not simplistic - a remarkable achievement. Interpreting research accurately and applying it intelligently are not easy tasks. This book has made them far easier. Every teacher should be given a copy.

Jonnie Noakes, Head of Teaching and Learning, Eton College, UK

This is the educational research book I have been waiting for!

As a profession, it is important that we are evidence-informed so that our most precious resource - time - is well spent on activities that will have the most impact on learning and progress for our students. But we are caught in the Catch-22 scenario of not having enough

time to engage fully with the research studies themselves. Add to this the problems of academic paywalls, complex and frequently impenetrable presentation and language style, and the sheer volume of educational research available, and the opportunity cost becomes too high for a busy teacher to read the journal articles that might just help them be more effective.

Fortunately, Busch and Watson have the solution in this instantly accessible summary of 77 vital research studies that every teacher should know. The vibrant, infographic-style presentation leaps off the page, and the structure of the book lends itself to browsing and dipping in-and-out rather than cover-to-cover reading. You can digest the key findings from an important study in just a few minutes - ideal for a busy teacher, whether in training, in the first few years of their career or wearing the badge of experience.

The studies themselves are well-chosen, covering the fields of memory, motivation and metacognition as well as behaviour, bias and parenting. The interleaved structure encourages the reader to see the connections between the studies too, building up a coherent overall picture of what might actually work in the classroom.

Busch and Watson have come up with that rarity: an educational must-read. I will be recommending it to every teacher I know!

Chris Hildrew, Headteacher, Churchill Academy, UK

Two key questions facing classroom teachers today are: firstly, what research do I need to know? and secondly, how can I use it in my classroom? This book is a highly practicable guide to the often-impenetrable field of education research and is a very useful compass for school leaders, classroom teachers and parents alike in seeking which evidence-based strategies to implement.

Carl Hendrick, Author, *What Does This Look Like in the Classroom?*, UK

Like me, I trust you will enjoy reading, dipping into, thinking about, following up, questioning and asking for more - as you touch this book. This is my "book of the decade".

John Hattie, Laureate Professor, Melbourne University, Australia

The presentation of the topics in 77 succinct sections make this a really accessible, easy to use book. It's not daunting to just tackle one topic at a time, and in total the articles add up to really practical and useful knowledge, presented clearly.

Sarah Brew, *Parents in Touch*

If you're a teacher who wants to find out about many interesting findings from educational research, without having to spend precious free periods or leisure time looking for it, you should buy this book. And if you're a team leader, buying a copy for each member of your team would not be a bad investment - especially if you used selected studies as the basis for team discussions.

Terry Freedman, *Schools Week*

This is a really excellent resource for the busy teacher, education student or study support tutor with plenty of food for thought and easy to understand classroom or teaching suggestions.

Jan Beechey MCILIP, *Dyslexia Review*

THE SCIENCE OF LEARNING

Supporting teachers in the quest to help students learn as effectively and efficiently as possible, *The Science of Learning* translates 99 of the most important and influential studies on the topic of learning into accessible and easily digestible overviews. Building on the bestselling original book, this second edition delves deeper into the world of research into what helps students learn, with 22 new studies covering key issues including cognitive-load theory, well-being and performing well under exam pressure.

Demystifying key concepts and translating research into practical advice for the classroom, this unique resource will increase teachers' understanding of crucial psychological research so they can help students improve how they think, feel and behave in school. From large- to small-scale studies, from the quirky to the iconic, the book breaks down complicated research to provide teachers with the need-to-know facts and implications of each study. Each overview combines graphics and text, asks key questions, describes related research and considers implications for practice. Highly accessible, each overview is attributed to one of seven key categories:

- Memory: increasing how much students remember
- Mindset, motivation and resilience: improving persistence, effort and attitude
- Self-regulation and metacognition: helping students to think clearly and consistently
- Student behaviours: encouraging positive student habits and processes
- Teacher attitudes, expectations and behaviours: adopting positive classroom practices
- Parents: how parents' choices and behaviours impact their children's learning
- Thinking biases: avoiding faulty thinking habits that get in the way of learning

A hugely accessible resource, this unique book will support, inspire and inform teaching staff, parents and students, and those involved in leadership and CPD.

Edward Watson is the founder of InnerDrive, UK.

Bradley Busch is a chartered psychologist at InnerDrive, UK.



Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

THE SCIENCE OF LEARNING

99 Studies That Every Teacher Needs
to Know

Second Edition

Edward Watson and Bradley Busch

Second edition published 2021
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

and by Routledge
52 Vanderbilt Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

© 2019 Edward Watson and Bradley Busch

The right of Edward Watson and Bradley Busch to be identified as authors of this work has been asserted by them in accordance with sections 77 and 78 of the Copyright, Designs and Patents Act 1988.

All rights reserved. No part of this book may be reprinted or reproduced or utilised in any form or by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying and recording, or in any information storage or retrieval system, without permission in writing from the publishers.

Trademark notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

First edition published by Routledge 2019

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data

Names: Watson, Edward, author. | Busch, Bradley, author.

Title: The science of learning: 99 studies that every teacher needs to know/Edward Watson and Bradley Busch.

Description: 2nd edition. | Abingdon, Oxon; New York, NY: Routledge, 2021. | Includes bibliographical references.

Identifiers: LCCN 2020047352 | ISBN 9780367620844 (hardback) | ISBN 9780367620790 (paperback) | ISBN 9781003107866 (ebook)

Subjects: LCSH: Learning, Psychology of. | Learning - Research. | Teaching-Research.

Classification: LCC LB1060 .B875 2021 | DDC 370.15/23-dc23

LC record available at <https://lccn.loc.gov/2020047352>

ISBN: 978-0-367-62084-4 (hbk)

ISBN: 978-0-367-62079-0 (pbk)

ISBN: 978-1-003-10786-6 (ebk)

Typeset in Interstate
by Apex CoVantage, LLC

BB: To Pippa, thank you for teaching me so much. To my not-so-little-big-boy Jacob, I hope you keep learning it all.

ETW: To Helen, Izzy, Ollie, Twiggy and Pavlov; thanks for putting up with my failings, for celebrating my successes and for being with me during the journey between the two.

From both of us, a big thank you to Routledge, our publishers, for taking a chance on us. A special thanks to Clare, whose original idea paved the way for this book and to both Annamarie and Alice, whose help, support and patience has been invaluable.

To our wonderfully talented graphics designer, Luis, a big thank you! We love your beautiful artwork - your creative talents are essential and much appreciated.














Thank you to the many researchers whose studies we have described. We hope that we have done your research the justice it deserves. And finally, thank you to all the members (past and present) of the InnerDrive team. In particular, thanks to DC, Blythe, Marayka, Emily, Izzy, Tom, Grace, Hattie, Ruhee, George, Ludmilla and Matt. We have loved working with you all. A big thank you also to Dan - we couldn't have done any of this without you.



Taylor & Francis

Taylor & Francis Group
<http://taylorandfrancis.com>

CONTENTS









| | |
|---|-----------|
| <i>About the authors</i> | xv |
| <i>Foreword from the first edition - John Hattie</i> | xvi |
| <i>How teachers use it</i> | xviii |
| Introduction | 1 |
| STUDIES | 5 |
|  1 The one about memory | 7 |
|  2 The one about aspirations and expectations | 9 |
|  3 The one about the planning fallacy | 11 |
|  4 The one about spacing your learning | 13 |
|  5 The one about growth mindset | 15 |
|  6 The one about predicting future behaviour | 17 |
|  7 The one about teacher mindset | 19 |
|  8 The one about teenagers and social rejection | 21 |
|  9 The one about teacher expectations | 23 |
|  10 The one about IQ and success | 25 |
|  11 The one about parents and grades | 27 |
|  12 The one about student resilience | 29 |
|  13 The one about marshmallows and self-control | 31 |

| | | |
|--|---|-----------|
|  14 | The one about mindset and purpose | 33 |
|  15 | The one about spacing and interleaving | 35 |
|  16 | The one about parental views on failure | 37 |
|  17 | The one about revising to music | 39 |
|  18 | The one about the Dunning-Kruger effect | 41 |
|  19 | The one about parental praise | 43 |
|  20 | The one about effort being contagious | 45 |
|  21 | The one about teacher evaluation | 47 |
|  22 | The one about talent bias | 49 |
|  23 | The one about retrieval practice | 51 |
|  24 | The one about thought suppression | 53 |
|  25 | The one about effective feedback | 55 |
|  26 | The one about motivating bored students | 57 |
|  27 | The one about self-analysis over time | 59 |
|  28 | The one about asking why | 61 |
|  29 | The one about sleep | 63 |
|  30 | The one about mobile phones | 65 |
|  31 | The one about marshmallows, reliability and self-control | 67 |
|  32 | The one about note-taking | 69 |
|  33 | The one about Impostor Syndrome | 71 |
|  34 | The one about reading out loud | 73 |
|  35 | The one about eating breakfast | 75 |
|  36 | The one about streaming | 77 |
|  37 | The one about academic buoyancy | 79 |

| | | |
|--|---|-----|
|  38 | The one about the spotlight effect | 81 |
|  39 | The one about resilience | 83 |
|  40 | The one about phones and sleep | 85 |
|  41 | The one about pictures and words | 87 |
|  42 | The one about teaching others | 89 |
|  43 | The one about experts overclaiming | 91 |
|  44 | The one about the Köhler effect | 93 |
|  45 | The one about the IKEA effect | 95 |
|  46 | The one about parental beliefs | 97 |
|  47 | The one about motivation | 99 |
|  48 | The one about student daydreaming | 101 |
|  49 | The one about banning mobile phones | 103 |
|  50 | The one about going for a walk | 105 |
|  51 | The one about stress mindsets | 107 |
|  52 | The one about how to give better feedback | 109 |
|  53 | The one about self-talk | 111 |
|  54 | The one about parents and reading | 113 |
|  55 | The one about the seduction of neuroscience | 115 |
|  56 | The one about deadlines, choice and procrastination | 117 |
|  57 | The one about smart reputations | 119 |
|  58 | The one about emotions and achievement | 121 |
|  59 | The one about interacting with nature | 123 |
|  60 | The one about stress and uncertainty | 125 |
|  61 | The one about metacognition | 127 |

| | | |
|--|--|-----|
|  62 | The one about helping disadvantaged students | 129 |
|  63 | The one about picturing the process | 131 |
|  64 | The one about what teachers say | 133 |
|  65 | The one about parental warmth | 135 |
|  66 | The one about how much we forget | 137 |
|  67 | The one about homework | 139 |
|  68 | The one about mindset, attitude and self-esteem | 141 |
|  69 | The one about pre-questions | 143 |
|  70 | The one about the learning style myth | 145 |
|  71 | The one about eating dinner together | 147 |
|  72 | The one about electronic note-taking | 149 |
|  73 | The one about the bandwagon effect | 151 |
|  74 | The one about struggling scientists | 153 |
|  75 | The one about effective teachers | 155 |
|  76 | The one about retrieval practice and stress | 157 |
|  77 | The one about false confidence | 159 |
|  78 | The one about sound in PowerPoints | 161 |
|  79 | The one about identifying expert teachers | 163 |
|  80 | The one about reading and background noise | 165 |
|  81 | The one about transitioning to secondary school | 167 |
|  82 | The one about drawing for learning | 169 |
|  83 | The one about effective teacher-student interactions | 171 |
|  84 | The one about how metacognition helps | 173 |

| | | |
|---|--|------------|
|  85 | The one about parental involvement | 175 |
|  86 | The one about bad decision making | 177 |
|  87 | The one about age and academic self-concept | 179 |
|  88 | The one about self-regulated learning | 181 |
|  89 | The one about cognitive load | 183 |
|  90 | The one about the effects of screen time | 185 |
|  91 | The one about perfect multiple-choice tests | 187 |
|  92 | The one about parents and sleep | 189 |
|  93 | The one about classroom decorations | 191 |
|  94 | The one about summer learning loss | 193 |
|  95 | The one about knowing the end is near | 195 |
|  96 | The one about interleaving and discrimination learning | 197 |
|  97 | The one about how teachers give feedback | 199 |
|  98 | The one about the peak end effect | 201 |
|  99 | The one about the importance of failing | 203 |
| TIPS | | 205 |
|  Tips for improving memory | | 206 |
|  Tips for improving mindset, motivation and resilience | | 207 |
|  Tips for improving self-regulation and metacognition | | 208 |
|  Tips for students | | 209 |
|  Tips for teachers' attitudes, expectations and behaviours | | 210 |
|  Tips for parents | | 211 |
|  Tips for overcoming thinking biases | | 212 |

| WHEN THE SCIENCE OF LEARNING MEETS THE ART OF TEACHING | | 213 |
|---|--|------------|
|  When the science of learning meets the art of teaching | | 214 |
|  Retrieval practice | | 215 |
|  Creating a growth culture | | 216 |
|  Developing independent learners | | 217 |
|  Managing mobile phones | | 218 |
|  Mastering your classroom | | 219 |
|  A home environment that aids learning | | 220 |
|  Improving self-awareness through self-reflection | | 221 |
| <i>Reference list: the studies</i> | | 223 |

ABOUT THE AUTHORS

Edward Watson is a graduate of Oxford University who served seven years in the Army. After receiving an MBA at The London Business School, he worked as a strategic management consultant for Marakon Associates before running businesses in the computer games market. As well as working in the corporate, education and sport sectors, he is also the co-author of *Release Your Inner Drive*.

Bradley Busch is a chartered psychologist. With extensive experience working in schools, he is a leading expert at helping schools utilise psychological research. Outside of education, Bradley works with elite athletes that include England international footballers and members of Team GB. He is the co-author of *Release Your Inner Drive*.

If you want to chat to Edward or Bradley about The Science of Learning, or about staff and student workshops, you can email them on info@innerdrive.co.uk.

FOREWORD FROM THE FIRST EDITION

In the good ol' days, research went through a peer-review process, was published, subject to replication and falsification, and followed rules of behaviour that have been handed down and refined since the 16th century. The basic premise was to follow Newton's dictum to stand on the shoulders of giants and continually add, refine and interpret the evidence in these published articles. But there was a late-20th-century explosion in the volume of evidence, an opening (via the internet) to access this volume of research, and the older rules of who published and what was published were questioned and often discarded. We are now in the days of evidence - mountains of it. The calls to use evidence are now everywhere, from politicians, parent groups, policy makers and educators - but whose evidence?

At the same time, the growth of denialism has exploded, and we have major world leaders using denial as the basis of populist electioneering: fake news, "lies, damn lies, and statistics", skills in clickbaiting, never letting evidence get in the way of a good argument (especially when it is my argument). We are indeed in the days of "post-truth" (the OED word of the year for 2016). "Truth is dead, facts are passé". Rhetorical effluent, passing the pub test, the smell test are the new norms.

My own exploration of this phenomena began when I noted that every educator seemed to know the secret to making schools successful - and the answer seemed to be what they were researching. And they had evidence, buckets of it, to support their claim. I was a student in these schools once and many of these claims did not ring true. My venture was to change the debate from "what works" to "what works best" and to ask the relativity question. Then, the pursuit of evidence - in my case, the synthesis of meta-analyses to create a relative ordering of effective interventions. Perhaps the most surprising news was that more than 95% of the interventions we implement to enhance student achievement work! I then wanted to change the bar - asking not what improves achievement but what discriminates between those interventions with high compared to lower positive effects. Ninety thousand studies, one-quarter of a billion students and 250 influences later, there is a set of claims - and, not surprisingly, my interpretations are hotly contested (as they should be).

Perhaps the days of asking for more evidence are passing. Given the volume of “evidence”, maybe it is time to move past asking for more evidence and ask for more interpretation and dissemination of the evidence. The Education Endowment Fund is an exemplar at this translation, but more is needed. Perhaps an even greater need is to have more effective models for implementing the translation of evidence. I very much like the notion of “translation”, as it puts the emphasis on those translating to ensure that the reader actually understands - otherwise there is no or poor translation. This is possibly the next most exciting development in our research world - translating the research so that it can be more readily implemented.

Here is where this book makes a major advance. When the authors sent me the page on my work to fact-check, I was seriously impressed with their skills of taking big ideas and presenting them in digestible form - without talking down, without missing key moderators and with much panache. The combination of the visual and verbal is impressive, the 77 major messages of high importance and the layout easy to navigate.

Take two of their messages: studying words and pictures together led to correctly answering more than twice as many questions as those who had revised with only words or with only pictures; and “the one about picturing the process”. They obviously listened to themselves, as the book is structured around the research on these two messages. Not only are the pictures perfect for ease of understanding, for use in professional development and for implications for practice, but they also provide the original references and hot tips at the end.

In 1921, Fred Barnard devised an ad using the phrase: “one look is worth a thousand words” and claimed it was “a Chinese proverb so people would take it seriously”. Bradley Busch and Edward Watson have certainly taken the research on cognitive and neuroscience seriously and turned thousands of words into magnificent pictures. And this is the skill that leads to more effective implementation of research that is so sorely needed in these days of evidence.

Like me, I trust you will enjoy reading, dipping into, thinking about, following up, questioning and asking for more - as you touch this book. This is my “book of the decade” and may there be many more like this.

John Hattie

HOW TEACHERS USE IT

Our aim is for this book to inform and stimulate discussion about the science of learning and its application to classroom teaching. Here are some ideas about how to use the book more widely within teacher CPD from those who read the first edition:

I've found the book *The Science of Learning* both interesting and helpful. Reading the classroom implications has been particularly useful, providing me with handy tips and methods to incorporate in my teaching. For example, I have applied the findings from Study 15 to my maths planning for Fractions, Decimals and Percentages. I spaced out the teaching of the material and in the lead up to the tests, ensured that there was a range of problems for the children to solve that required them to consider which skills they would need to employ. This approach meant that children felt more confident about the prospect of taking the tests and, for the most part, were pleased with the results.

Study 42 was useful and had a positive impact on children's learning in maths. For example, knowing that they were about to be placed into random groups in maths for a mixed number/improper fraction treasure hunt, increased their focus during the whole class explanation. They were told that all members of the group would be asked at the end of the activity to complete one question correctly before being declared the winners. Therefore, they realised the importance of being able to teach those who might experience difficulties with the concept. Another reason for increased focus was fear of letting the other group members down.

We do the "Daily Mile" at our school, but Study 50 reminded me of the benefits of taking a break from learning and going for a walk. This is something that we do from time to time with positive results in terms of renewed energy and application.

- Elaine Prendiville, Winnersh Primary School

Over the past year in my role as Assistant Principal i/c I have implemented a vision of research-based practice for all our CPD. This means that we think carefully as an SLT about what CPD we plan and make sure it is something which will have real proven impact in the

classroom and is not a gimmick. We also always make sure that when we introduce any new strategies, that we communicate why we are introducing them and the benefit the change will have on pupils. For this reason, *The Science of Learning* has been crucial for us.

One key strategy we have implemented this year for example, is that of retrieval practice. Through delivering regular Teacher Learning Communities (small cross-subject groups) we outlined what retrieval practice is and some key ways it can be implemented for different subjects. However, the most important part of this process, was sharing what the evidence says. Through using the brilliant visual information in the book, we were able to communicate the Roediger and Karpicke study which outlined the testing effect and the benefits of retrieval over re-reading. We have seen over the past few months a huge increase in staff embedding retrieval practice into lessons and in turn more confidence and increasing amounts of knowledge by pupils. For example, the History department has implemented the pomodoro technique of revision using 20 minute blocks where pupils write down everything they remember about a topic and then only when they have exhausted this do they use a textbook to add in the extra information.

Most subjects are now starting lessons with a quiz or brain dump. "Flashback Friday" and "Throwback Thursday" are proving very popular! This is something we will continue to embed over the next few months and believe it is having a real effect on pupil progress. This is one example of how we have used the studies in the book, but it really is an invaluable resource for us both for classroom teachers and for SLT planning CPD.

- Rachel Ball, Co-op Academy, Walkden

The Science of Learning is incredibly important at my school as we have four key priorities with teaching and learning which are literacy, questioning, feedback and cognitive science. This is across the whole school and at a departmental level. The two areas my History department have been focusing on with regards to the science of learning are retrieval practice and dual coding. The sections in the book dedicated to memory have been very insightful, informative and helpful with our curriculum and lesson planning. It is a key aspect of our development plan and professional development. We have taken the research findings and discussed what the implications for these are in our day to day planning and practice. The science of learning has helped me to reflect on my lessons and adapt them to become more evidence informed.

As a result of reading the book, changes have been made with how we support students with their revision strategies both from an academic and pastoral perspective. I have also reflected on how and when I use retrieval strategies in the classroom. The main way I have adapted my teaching has been my focus on revision strategies and metacognition. The book has had the greatest impact on me in my pastoral role as a GCSE class form tutor. I regularly share the research from this book with my tutees to help them understand how they can apply it to their studies. Using information in this book I also created a presentation that I

delivered to parents of students in Years 10 & 11 about how they can support their child with their studies, advising what their children should and should not do. Parents found this very useful and I think many parents would find the book very helpful too.

The research study that myself, my colleagues and students found the most surprising was about the impact of the presence of a mobile phone and how distracting it can be. This is really important and screen time is something that continues to be an issue. I also found the studies about listening to music when trying to study too.

Finally, the layout of this book is incredible. Trying to read academic research papers can be very problematic. They can be difficult to access, very lengthy and filled with academic jargon. This book does a great job at summarising key studies, some I was familiar with but many I wasn't. I think a misconception about this book is that people assume it is just about cognitive psychology and memory, but it goes far beyond. It covers a wide range of topics useful for any teacher, middle or senior leader as well as being accessible for students and parents too.

- Kate Jones, The British School Al Khubairat, Abu Dhabi

We at Loughborough Amherst School have been using *The Science of Learning* ever since I attended one of your courses. The book mirrors the course: really simple to follow and easy to just pick up quickly & then put down again in the middle of busy teaching lives. I love the fact that although the basic T&L concepts aren't necessarily new, they are explained really clearly so that everyone (pupils and parents as well) can understand the theory. The use of science to back up every point leaves no room for argument which pupils dispute why they absolutely can multitask and listen to music, talk and play on their phones all whilst also working! We have given every member of our staff a copy of the book - and it was worth every penny in terms of CPD that everyone can find something useful and inspirational from. Thank you to all at InnerDrive for your hard work and I can't wait to see the next book!

- Grace Davies, Loughborough Academy

Over the past year my role as a teacher of History has changed drastically. Personally, I am able to look at studies from researcher Khattab about student aspirations and expectations and realise that I need to encourage a lift in both of these in order for my students to progress. As a department, the structure of our curriculum and practice has been dictated by research rather than what is considered 'fashionable' at the time. This refreshing look at teaching has been informed and inspired by studies provided in *The Science of Learning*, ensuring that teachers are developing themselves through rigorous CPD sessions that are tailored for our needs.

As a CPD lead in the school, I have been able to refer back to the book to create resources for CPD sessions and foster meaningful conversations and discussions between the teachers in the

school. One fundamental strategy to further the progress of pupils in the school that has been introduced this year is the use of retrieval practice. This has now been rolled out across the school, and staff are becoming more and more confident every time they use a certain retrieval method. Through using the visual accessibility of the book, we have been able to communicate the studies from Roediger and Karpicke around the benefits of re-reading for retrieval, as well as the Dunlosky study on improving long-term memory. This is just one example of how this book has aided our progress as a school. The positivity with which this has been received by members of staff within CPD groups has been incredibly encouraging and shows that using this book works.

- Brad Williams, Co-op Academy, Walkden

I've used *The Science of Learning* extensively when leading on Teaching and Learning at West Coventry Academy. I produced readers of key studies for teachers and based a lot of the whole-school CPD sessions I designed around the accessible, easily digestible infographics and summaries. Fellow educators who I introduced to the book never fail to be impressed by its clear and concise structure and the power of the research findings behind it.

- Bertram Richter, Coventry Academy

What I love most about this book is its versatility. I sat down to read this book for my own interest as a teacher but quickly realised how I could use it as a form tutor, a head of department and as a teacher. For example, we have read and discussed studies in form time before - I asked students to consider the article about sleeping patterns before they kept a 'sleep diary' to monitor their behaviour for 2 weeks and reflect on how their behaviour compared to that advocated in the study of your book.

I have been able to use the book in so many different ways because it is so readable. The layout and language means that it is accessible to all - and also enjoyable to read. There are so many education books out there that 'drag on' - they are a book when they could have been a blog post. The book by InnerDrive thus stands out - each page is valuable and insightful and there are no wasted words!

My teaching has changed because of the insights gained in the studies of the book. Again, another unique feature of the book is the ease with which you can dip into it - using the contents page to find a study and read it before tweaking your teaching behaviour the next day. This allows it to be a highly useful book that really does change your practice.

- Kate Stockings, Hamsptead School

Introducing the book with questions and challenges definitely worked with quizzical, cynical and conservative colleagues as it started interrogation and discussions. These have been

raised in monthly videos produced by teachers and then shown and shared across the group. Each video has taken one study and discussed it in the context of schools with students from over eighty different learning backgrounds.

'The plan' had envisaged setting up discussion groups between teachers but we did not need to facilitate these - they occurred naturally. Some were amongst subject specialists, others with pastoral practitioners, some within schools, some across sites. Something that surprised me was how many non-teaching colleagues were suddenly demanding a copy, 'I work in a school - I want to know more about learning - so I can help the students more' was a sentiment I heard from sales colleagues, cleaners, activity co-ordinators and many other members of our teams. Once again, getting colleagues to ask questions was key.

- How can I help develop learning in my role (whatever it is)?
- How in my interactions with students can I get them talking about good practice in learning?
- Which myth do I want to bust this week?

Different schools across the group have used the book differently but these have included: line managers using it as a focus for observation feedback conversations, asking teachers to identify something they would like to develop; students presenting studies to each other in tutor time; boarding staff asking students which of the studies they have seen evidence of in their lessons, and each week one study is highlighted with posters around the schools.

No resource is perfect for all contexts, but the well-thumbed and annotated copies of this book lying around our schools is evidence that, in our context, giving every teacher a copy has been beneficial. As educators, sometimes we all need reminding that as well as being pastoral agents we are crafts people. We use the skills of our profession to fashion learning. This book gets us thinking about how to hone the skills and ensure that they what we do is based on research. Use it - don't just read it.

- George Casley, CATS College London

Introduction

What is the science of learning? It is the quest to help our students learn more effectively and efficiently. Despite there being a wealth of research on the science of learning, to date, much of it has failed to get into the hands of the people who need it the most - that is, teachers.

There are three probable reasons for this:

- 1 Most people aren't too sure where to look for this sort of research.
- 2 If you did know where to look, you either have to pay lots of money to read the journals or have a current university subscription.
- 3 If you do have access to these studies, some of them are very hard to read and make sense of. For instance, this is how one of the results from a study we really like appears in its journal:

$$\text{Rating}(k) = \beta_1 \text{rating}^{(k-1)} + \sum_{i(k-1)}^{i(k)} \beta_2 \text{shocks}^{(k)} + \beta_3 \text{variable term}^{(k)}$$

This book seeks to fix those problems.

Where we were

The first edition of *The Science of Learning* was born out of frustration that there was a wealth of research out there that was stuck behind paywalls, difficult to locate and not obviously translatable into practical strategies. And yet, as a profession, education was becoming more and more informed by the research, with the desire to understand what works best in different situations growing significantly.

Our aim was to assist and encourage that movement by providing a brief synopsis of studies that we found interesting and useful, along with a summary of some of the related research and key classroom implications. Above all, we wanted to make research findings accessible, the complex simple and the theoretical practical.

Where we are

So, did *The Science of Learning* achieve its goals? The book has been read by teachers in thousands of schools. We've had reports of teachers reading it in all corners of the world, including England, India, Australia and America. It is also currently being translated into Chinese, Korean and Spanish.

Why a second edition, then? The science of learning never stands still. Our understanding of the factors that help students learn best is constantly evolving and developing. With fascinating new research being produced on a daily basis, there simply were more studies that we wanted to include.

This book includes studies from researchers in England, America, China, New Zealand, Canada, Japan, Australia, Germany, Spain, France, Holland, Belgium and Israel. We hope you find them as interesting, helpful and thought-provoking as we did. Some of the studies we have chosen are iconic. Some are quirky. Some are large-scale and some have a small sample size. This second edition contains some that are very old, and many that are very recent. Some have tracked students for more than 40 years, whereas others were done in just one day. But what they all have in common is they help us to paint a picture of the science of learning.

Where we want to be

We started the first edition with a quote from the Scottish poet Andrew Lange, who once said that "some individuals use statistics as a drunk man uses lamp-posts - for support rather than for illumination". We think the same can be true for psychology research papers. Our understanding of how people learn is constantly developing - with new studies being released and some old studies failing to replicate. What we 'know' is not a fixed or static thing. Therefore, this book represents our current understanding based on psychological research.

We want this new edition to be used as a springboard for high-quality discussions in the staff room, which will drive real change in the classroom. Author, anthropologist and filmmaker Zora Neale Hurston once said that "research is formalised curiosity. It's poking and prying with a purpose". If this new edition of *The Science of Learning* is used as a foundation to spark debate, discussion and even disagreement, then we will be very happy.

We know that nothing works everywhere or all of the time. But using research as a platform to discuss why we do what we do and what we think best serves our students is a healthy place for education to be. If we all have that debate, all our students will benefit.

How We Wrote This Book

This book isn't written like most other books. As well as writing about the findings of the science of learning, we designed the book to reflect these findings. So for example, we have mixed up the order of topics as recommended in **Study #4**. We have combined pictures and words (**Study #41**) and asked key questions at the start of most of them (**Study #69**).

If you do want to read the studies on a particular area, then the topics that we cover are colour-coded as follows:



Memory

Strategies that improve how much students remember things.



Mindset, Motivation and Resilience

How to improve persistence, effort and attitude.



Self-Regulation and Metacognition

Helping students to think clearly, helpfully and consistently.



Student Behaviours

The key student habits and processes that make a meaningful difference.



Teacher Attitudes, Expectations and Behaviours

Important classroom practices that affect student learning.



Parents

The fundamental choices, decisions and behaviours that parents make and how they impact their children's learning.



Thinking Biases

The faulty thinking habits and quirks that get in the way of learning taking place.