The enactment of cognitive science-informed approaches in the classroom

Jørgensen, Clara; Perry, Tom; Lea, Rosanna

DOI:
10.1080/00071005.2023.2245438

Document Version
Publisher's PDF, also known as Version of record

Citation for published version (Harvard):
Jørgensen, C, Perry, T & Lea, R 2023, 'The enactment of cognitive science-informed approaches in the classroom: – teacher experiences and contextual dimensions', *British Journal of Educational Studies*, pp. 1-20. https://doi.org/10.1080/00071005.2023.2245438

British Journal of Educational Studies

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rbje20

THE ENACTMENT OF COGNITIVE SCIENCE-INFORMED APPROACHES IN THE CLASSROOM – TEACHER EXPERIENCES AND CONTEXTUAL DIMENSIONS

Clara Rübner Jørgensen, Thomas Perry & Rosanna Lea

To cite this article: Clara Rübner Jørgensen, Thomas Perry & Rosanna Lea (07 Sep 2023): THE ENACTMENT OF COGNITIVE SCIENCE-INFORMED APPROACHES IN THE CLASSROOM – TEACHER EXPERIENCES AND CONTEXTUAL DIMENSIONS, British Journal of Educational Studies, DOI: 10.1080/00071005.2023.2245438

To link to this article: https://doi.org/10.1080/00071005.2023.2245438

British Journal of Educational Studies
Vol. 00, No. 00, XXXX 2023, pp. 1–20

THE ENACTMENT OF COGNITIVE SCIENCE-INFORMED APPROACHES IN THE CLASSROOM – TEACHER EXPERIENCES AND CONTEXTUAL DIMENSIONS

by CLARA RÜBNER JØRGENSEN, *Department for Disability Inclusion and Special Needs, School of Education, University of Birmingham, Birmingham, UK*, THOMAS PERRY, *Department for Education Studies, University of Warwick, Coventry, UK* and ROSANNA LEA*, *School of Education, University of Birmingham, Birmingham, UK*

ABSTRACT: Cognitive science-informed approaches have gained considerable influence in education in the UK and internationally, but not much is known about how teachers perceive cognitive science-informed strategies or enact them within the contexts of their everyday classrooms. In this paper, we discuss the perceptions and experiences of cognitive science-informed strategies of 13 teachers in England. The paper critically explores how the teachers understood and used cognitive science-informed strategies in their teaching, their views of the benefits and challenges for different subjects and groups of learners, and their reflections on supporting factors and barriers for adopting the strategies in their schools. The teachers' accounts illustrate some of the many complexities of adopting cognitive science-informed approaches in real-life educational settings. Drawing on their narratives, the paper emphasises the importance of acknowledging different contextual dimensions and the dynamic interactions between them to understand when and how teachers enact cognitive science-informed approaches in their classrooms.

Keywords: cognitive science-informed approaches, educational practice, enactment, teacher perspectives

1. INTRODUCTION

Cognition has a central role in learning and two areas of cognitive science have been especially influential for educators seeking a scientific basis for their work: cognitive psychology and cognitive neuroscience. Both areas of cognitive science are currently and increasingly informing interventions, practice, and policy in education in England and internationally (Department for Education,

*She is now at the Education Endowment Foundation

ISSN 0007-1005 (print)/ISSN 1467-8527 (online)

https://doi.org/10.1080/00071005.2023.2245438
http://www.tandfonline.com

2019; Kitchen, 2021; Ofsted, 2019; Tommerdahl, 2010). There is a growing body of policy and practice-oriented literature recommending specific strategies informed by cognitive science, such as for example spaced practice, retrieval practice, dual coding, and strategies designed to reduce students' 'cognitive load' (e.g., Deans for Impact, 2015; Putnam and Roediger III, 2018; Richens, 2021; Rosenshine, 2010). The focus on cognitive science in education coincides with an increasingly influential 'what works' agenda in education, which emphasises 'evidence-based decisions' as the foundation for educational practice (Pampaka *et al*., 2016). However, what counts as evidence, and statements about 'what works', often pay relatively little attention to the complex contexts in which education takes place and the many dynamic and political negotiations and interactions going on within and across schools.

Several reviews have evaluated the research evidence for particular cognitive science-informed strategies in education (e.g., Agarwal *et al*., 2021; Dunlovsky *et al*., 2013; Pashler *et al*., 2007; Weinstein *et al*., 2018) and suggested strategies with the highest impact on most students and subjects. Such reviews are generally not designed to explore the potentially complex benefits or disadvantages for specific subject areas, particular groups of students or specific learning contexts. Practical guides for cognitive science strategies in education similarly include many well-constructed examples and illustrations of how teachers can implement particular cognitive science-informed strategies in their lessons (see for example The Ambition Institute, 2020; Riccomini and Morano, 2019; Rosenshine, 2010), but less critical discussion of contexts and applications for specific groups of children. Most such guides are specifically designed as instructional aids to support teachers adopt the strategies, rather than as an account of what teachers do and experience as outcomes of doing so. In general, not much is known about how teachers understand, experience and negotiate cognitive science-informed strategies in their classrooms and what barriers and supporting factors they encounter in the process.

In this paper, we begin to address this knowledge gap through an analysis of 13 semi-structured qualitative interviews with practicing teachers in England. The interviews formed part of a larger review of cognitive science in the classroom, funded by the Education Endowment Foundation. The core focus of the study was a systematic review of the scientific literature on cognitive science in the classroom, reported elsewhere (Perry *et al*., 2021). In parallel to the systematic review, a practice review was carried out, with the overall objectives of exploring what practitioners in England identify and recognise as common approaches based on cognitive science and what form(s) applications of cognitive science take in practice, including how they differ for different subjects and students. The practice review consisted of a review of practice-oriented literature, a questionnaire survey of 808 teachers, and the 13

semi-structured interviews with teachers. The data presented in this paper predominantly derive from the interviews, as they provided the most in-depth, detailed and rounded account of teachers' experiences of enacting cognitive science-informed strategies in their specific contexts. Where relevant we have also included selected figures from the survey to support particular findings.

In the interviews, the teachers shared their views and experiences of cognitive science in education, spanning from broad and general considerations about the role of cognition in learning to very specific examples of how they applied particular cognitive science-informed strategies in their classrooms and what they had found worked best in their particular contexts and with their specific groups of students. In combination, the teachers' accounts begin to paint a picture of some of the many contextual factors impacting on how cognitive science-informed approaches may be adopted in education. The teachers' narratives also showed acute awareness of the interpersonal elements of teaching and the importance of not seeing cognitive science-informed strategies as practiced in a vacuum. These insights form the basis for the themes discussed in this paper.

In the first part of the paper, we discuss the background for the paper and present the methods applied in the practice review, particularly in the interviews. In the second part, we present the main findings from the interviews, organised around four main themes: 1) teachers' understandings and experiences of cognitive science-informed strategies, 2) teaching contexts, 3) school approaches and dynamics, and 4) teachers' reflections on outcomes. We end the paper with a discussion of the contexts shaping the teachers' experiences and their implications for understanding and applying cognitive science-informed approaches in education.

2. Background

As Goswami (2006) has noted, in many schools there is a 'hunger' for more knowledge about the brain and how children learn. This 'hunger' is to some extent driven by policy, for example in England, where the recently updated Initial Teacher Training Core Content Framework (Department for Education, 2019) includes numerous references to insights and approaches derived from cognitive science. However, the literature has also cautioned against potential over- or misinterpretation of cognitive science evidence for use in education and alerted to the prevalence of neuromyths amongst teachers (Grospietsch and Mayer, 2020; Howard-Jones, 2014; McMahon *et al*., 2019; Thomas *et al*., 2019). Dunlovsky and Rawson (2015) have noted that since much of the evidence behind cognitive science-informed strategies stems from work done

in laboratories, there is still much to be discovered about how these techniques can best be applied in the classroom. Given this, cognitive science and education have been described as two disciplines characterised by a 'gap' (Howard-Jones, 2014), in need of 'bridging' (Aronsson, 2020) or even a 'bridge astray' (Dougherty and Robey, 2018).

The gap is particularly acute for educational neuroscience. Churches *et al*. (2020) outline three key challenges of collaborations between neuroscientists and educators: 1) that neuroscience and education are two disciplines with fundamentally different objectives, 2) that neuro-scientific and educational research take place at different levels (microscopic, individual and more social or collective levels) and only coincide at the level of individual behaviour, and 3) that there is a problem of translating neuroscientific research into something applicable in schools and classrooms. For example, they argue, 'it cannot be good enough to imply that testing [i.e., retrieval practice] will always work, for every teacher, in every situation, with all children – nor can it be acceptable to jump to similar conclusions about other evidence from the science of learning' (p. 6). These points raise the important question of how 'evidence' about a particular strategy can be translated into practice.

Equally important is the recognition that individual cognitive science-informed strategies often encompass significantly diverse practices, and that it is therefore challenging to draw undifferentiated conclusions about their overall effectiveness. Rather than prescriptive and highly defined pedagogical techniques, cognitive science provides principles and concepts connected to generalised strategies which teachers can then apply in their practice. Retrieval practice, for example, highlights the benefits of revisiting content over time and the value of students recalling information from memory rather than it being re-read or re-presented. However, a wide range of teaching techniques, including multiple choice tests, free recall practice tests, concept mapping, retrieval as part of homework, flashcard and self-quizzing, have all been described as adhering to the general principle of retrieval practice (Perry *et al*., 2021). Furthermore, research has found that some strategies work best when supported by other supplementary strategies (e.g., retrieval with feedback – Dunlovsky and Rawson, 2015) and wider classroom practices (socio-emotional learning, supportive learning environments and positive classroom relations – Darling-Hammond *et al*., 2020). These issues of translatability, diversity within strategies, and supporting factors all emphasise the importance of context when trying to understand whether or not a particular technique might work in a specific classroom.

Ball *et al*. (2012) have argued that educational policy research needs to take 'context seriously,' move beyond the 'de-politicised' concept of implementation and explore how schools 'enact' policies – i.e., how they navigate, negotiate,

interpret, contextualise, and put policies into action. They note that teachers are both 'actors and subjects, subject to and objects of policy' (p. 3) and that 'schools are made up of different types of, and different generations of, teachers with different dispositions towards teaching and learning, set within different waves of innovation and change' (p. 6). To understand the way policies are enacted in schools, Ball *et al*. (2012) argue that researchers need to pay attention to the history and location of schools and their intake (*situated context*); the values and management of schools and their workforce (*professional cultures*); the budget, buildings and infrastructure of schools (*material contexts*); and the broader policy context (*external contexts*).

Cukurova *et al*. (2018, p. 335) have also critiqued the lack of attention to contextual factors in the type of educational research that is based on 'systematic and statistical accumulation of results from experimental research studies.' Although such studies are often seen as 'the gold standard of evidence for practice,' Cukurova *et al*. (2018) argue that their value to practitioners is limited because systematic or statistic accumulation involves combining studies which 'on the face of it are similar, but in reality have significant differences.' Based on this, and their specific study of collaborative problem solving, Cukurova *et al*. (2018) provide a comprehensive taxonomy of potential contextual factors which can be accounted for in systematic reviews of educational interventions. Their taxonomy however does not include the dynamic and political negotiations and interpretations involved in more long-term or complex changes to practice, such as the ones described in this paper, which are more readily explored through qualitative methods.

3. Methods

This paper is based on 13 qualitative and semi-structured interviews with teachers, which were conducted as part of a larger practice review. The practice review as a whole consisted of: a *literature review* of academic articles specifically discussing practice, practice facing reports, teaching frameworks and resources, and more popular-scientific texts and web-resources aimed at practitioners, such as for example Educational Leadership, the Chartered College of Teaching and Education Week; a *survey* distributed via social media and various professional networks in November/December 2020, investigating teachers' familiarity with and views of the five key strategies of our systematic review (spaced practice, retrieval practice, dual coding, strategies to reduce cognitive load and interleaving); and the *qualitative interviews* with teachers. Interviewees were selected from a pool of over 200 survey respondents, who had indicated that they would be interested in being contacted for a further interview. Based on the background information they

TABLE 1: Interview participants

Gender	Phase of Education	Self-reported level of familiarity with Cognitive Science	Subject/Role	Years of experience
Male n = 6	Primary n = 4	Low/Medium n = 2	Maths	3–5
			Class teacher	6–10
		Medium/High n = 2	Head teacher	11+
			Maths	3–5
	Secondary n = 2	Low/Medium n = 1	Science	11+
		Medium/High n = 1	Physical Education	6–10
Female n = 7	Primary n = 1	Low/Medium n = 1	SENCo	11+
	Secondary n = 6	Low/Medium n = 3	English	11+
			English	6–10
			Evidence lead	6–10
		Medium/High n = 3	English	11+
			Design and Technology	11+
			Social science	11+

had provided in the survey, a diverse group of teachers was selected in terms of gender, primary/secondary school, familiarity with cognitive science (low/medium/high), subjects and years of experience (see Table 1, below).

As explained elsewhere (Perry *et al*., 2021), the majority of the survey respondents, from whom the interviewees were selected, reported either 'high' (35.9% to 69.2%) or 'moderate' (26.9 to 44.6%) knowledge of the five surveyed cognitive science-informed strategies and found the strategies 'highly important' for effective teaching and learning (51.7% to 89.9%). 71.1% furthermore 'strongly agreed' with the statement that 'All teachers should be taught cognitive science-informed teaching strategies.' Given this sample, we believe that the interviewees represent a particular sub-group of teachers, who were more likely than average to be interested in and positive about cognitive science. This can be seen as a limitation to our findings in terms of their representativeness of all teachers, but also an indication that even teachers who are relatively enthusiastic about cognitive science-informed approaches, encounter challenges and uncertainties, such as the ones discussed in our findings.

For the qualitative interviews, a semi-structured question guide was developed (Appendix A) based on the literature review and preliminary findings from the survey. The question guide aimed to explore teachers' perspectives on cognitive science-informed approaches in education and

their experiences of using different strategies in their classrooms. The question guide was also sufficiently flexible to allow teachers to introduce and expand on any areas they found relevant in relation to the overall interview topic. The interviews were carried out in December 2020 and January 2021, all but one via Zoom due to COVID-19 restrictions (the final one was conducted by telephone). The interviews lasted between 30 and 50 minutes and were voice-recorded, transcribed, and coded by the first author of the paper. The codes were reviewed and agreed upon by the research team and used to further analyse the interviews, adopting an inductive approach whereby the initial codes were grouped, first into six initial themes and later into the four more refined themes presented in this paper (Table 2).

The study had received full ethical approval from the University of Birmingham ethics committee prior to the survey and the interviews taking place. All participants completed an informed consent form before the interview and verbally re-confirmed their consent at the beginning of the interviews. The names of all participants and the educational settings and localities where they worked have been anonymized, and no names of any children or young people whom they worked with were mentioned in the interviews.

4. Findings

When asked about their first associations and experiences of cognitive science, some interviewees were fairly general in their answers, but most described practical examples from their classrooms. The most commonly described strategy in the interviews was retrieval practice (in various forms), but other approaches such as dual coding, spaced learning, interleaving and strategies to develop 'schema' or manage 'cognitive load' were also discussed (for a detailed description of these strategies, see Perry *et al*., 2021). In the following, we discuss the four themes developed from the narratives of the interviewed teachers: 1) teachers' understandings and experiences of cognitive science-informed strategies, 2) teaching contexts, 3) school approaches and dynamics and 4) teachers' reflections on outcomes.

Teachers' Understandings and Experiences of Cognitive Science-Informed Strategies

Five of the interviewed teachers explicitly mentioned that they and/or their school were (in their own words) 'quite new' to cognitive science, reflecting that the formal introduction of cognitive science in educational policy, training

TABLE 2: Initial codes and analytical themes

Initial codes	Initial themes	Refined themes
Evidence-based	Knowledge and understanding of cognitive science inspired strategies	Teachers' understandings and experiences of cognitive science-informed strategies
Relying on other people's research		
Difference between teachers		
Learning through social media		
Practical descriptions of particular strategies		
Variation in strategies		
Cog-Sci = control		
New names for old strategies		
Strategies can't stand alone		
Learning as complex	Teaching contexts	Teaching contexts
Curriculum		
Subject specificity		
Trauma informed learning		
Learning mindset		
Primary vs. secondary settings		
Experimentation		
Slow introduction		
Student diversity	Learners	
Student understanding of strategies		
Student age/level of study		
Student ability/attainment		
Whole-child		
Student buy-in/reception		
Relationships		
Impact of training/CPD	Whole-school vs. individual approaches	School dynamics and approaches
Teacher dialogue and exchange of ideas		
Teacher autonomy		
Teacher knowledge of strategies		
Whole school approach		
Workload	Barriers and supporting factors	
Time		
Performance	Measuring outcomes/ success	Teachers' reflections on outcomes
Outcomes		
Ofsted		

and guidelines is relatively recent. However, they also noted that some cognitive science-informed strategies resembled existing or traditional teaching methods, which teachers may already have been used to, albeit under a different name:

> I would use a quiz or like the test effect I think it was called before and it kind of for me just explained something that most teachers understood worked … so for me personally that was kind of my first association- it was just new names for some things. (Interview 4)

The view that 'cognitive science is a new way of talking about old teaching strategies' was shared by approximately 50% of the people responding to the survey, and thus seems to be quite prevalent amongst teachers. Nevertheless, the interviewed teachers also described that understanding the basis of cognitive science-informed strategies provided them with a common language, helped them articulate or understand their own practice, and increased their sense of control:

> [It] makes me feel like I've got more control because sometimes you think there's so many variables in the classroom, but … actually, cognition is making me think now that I can manage and control situations … Cognitive Science is absolutely your friend … (Interview 3)

> … a big part of cognitive science is helping the teachers articulate what they actually do. (Interview 1)

> I think it [learning about cognitive science] has really kind of strengthened my teaching practice … I felt more confident in what I was doing. (Interview 4)

When asked how they had come across the cognitive science-informed strategies they used for their teaching, the majority of the teachers described a 'snowballing' process, whereby they had encountered a cognitive science-related post, for example on social media, which had subsequently led to self-reflection and self-learning via books or other online resources:

> Quite often with teachers it comes from Twitter, so I think maybe a couple of years ago it was the Learning Scientists[1] and they were tweeting things and that kind of put them on my radar … and then about a year ago I read a book which was published by the Learning Scientists and it was all kind of dual coded and spelled out the different approaches and that for me kind of was when I had a quite clear picture of how it worked. (Interview 4)

This description of individual learning about cognitive science-informed strategies was also relatively common in the survey data, where approximately 40% of the responding teachers reported learning about the strategies independently

(Perry *et al*., 2021). However, some of the interviewed teachers also described being influenced by a particular training event they had attended, either at their own school or externally, or by their senior leadership team (SLT) who had introduced them to cognitive science-informed strategies, or a combination.

There was a general agreement amongst the interviewed teachers that cognitive science-informed strategies were evidence- or research- based:

> For me, cognitive science in the classroom is understanding the process by which we learn, and then which strategies we can use, which are backed by research and evidence, which shows that we can then adapt our teaching to make it more effective. (Interview 10)

Nevertheless, several of the teachers also emphasised the importance of teachers remaining critical, reflective, and not take for granted what 'the research is saying' (Interview 5). As pointed out by one of the teachers *'you can't just take one thing and say, that's the solution… One of the dangers is that people become too rigid in their approach and are not flexible to meet the needs of students (Interview 10)*. This quote illustrates the importance of teaching contexts, and the recognition that teachers need to be able to experiment to identify the right strategies for their particular setting, subjects and learners.

Teaching Contexts

When describing how they had used cognitive science-informed strategies in their classrooms, the majority of the teachers acknowledged the need to be flexible and pay attention to the fact that some strategies were more appropriate than others for particular settings. One teacher, who had experience of working in both primary and secondary schools, described some of the differences between the two in terms of the way the curriculum and the school day worked. He noted for example, that in primary school, he would not have to think as carefully about how he structured spaced practice, as he could do so across the whole curriculum, rather than in individual subject classes (Interview 5). Others talked about the applicability of particular cognitive science-informed strategies for specific subjects, for example, that Maths may not 'lend itself so well to interleaving' due to the importance of being able to separate difficult mathematical concepts and methods (Interview 4) or that dual coding could be particularly useful for concretising abstract concepts in English (Interview 3). Reflecting the recognition of such subject-related differences, one of the teachers called for more material on how cognitive science-informed approaches could be used in specific subjects:

> I think for it to be broadly effective, there will need to be some recognition that some of this will be different according to subjects and having something subject specific would be really powerful … something you can take off the shelf, subject-specific, something really accessible with examples. (Interview 10)

In the interviews, teachers were also asked about any particular benefits or challenges of cognitive science-informed approaches for different groups of children. Whilst the teachers generally perceived cognitive science-informed strategies as useful for all students, some specifically mentioned the benefits for particular groups of children, for example children with special educational needs or English as an additional language. One teacher in particular described cognitive science as a tool for addressing gaps between disadvantaged and advantaged pupils:

> I think people are more interested [than before]in why those gaps might exist and how to minimize them. And maybe cognitive science is one way of looking at strategies – it is all about getting the biggest win with the least effort, isn't it? (Interview 2)

However, another teacher made the important observation that strategies, for example quizzes to enhance retrieval, could also have negative effects on some students:

> It is not all good news. One child who gets the answer wrong, that is a quick failure. There is quick feedback in quizzing. But it can reiterate failure in some children, and I hadn't expected that at all, so it is about being aware of how it works on the ground. (Interview 5)

As illustrated by this quote, children are different in the way they respond to pedagogical strategies. They may furthermore have different experiences and types of engagement with learning depending on what else is going on in their lives. Knowing how the brain works was, by two of the interviewed teachers, described as helpful for understanding such differences, in particular the impact of childhood experiences and stress on learning:

> Some come in, still in that kind of like survival mode, some children are thinking about what's happening at home. Thinking of this in terms of cognitive load and things like that, their minds are elsewhere, so strategies that can kind of reduce that are quite good. (Interview 1)

In addition, one teacher made the important point that whilst cognitive science-informed approaches were an essential 'part of the package' they were not in themselves 'enough' to address these complex issues:

> There are lots of things that research informed strategies can't reach. But it's a crucial element of the formula. But you need other things alongside it. Because it doesn't matter how good my teaching is, if they don't want to engage, then it's not going to get through to them. (Interview 10)

When talking about their students, some of the teachers also discussed their different levels of understanding and 'buy-in' as a factor in how well strategies would work. For example, one teacher mentioned that her students, who were mostly psychology students, understood well the rationale behind dual coding, deeper processing, and spaced revision, but that others did not have the same understanding. The teacher furthermore noted the importance of explaining the rationale behind the different approaches to students as some of the strategies potentially clashed with established perceptions of learning:

> Sometimes students want [to be taught in] that old fashioned way, in particular, I'd say like the higher sets, the most able students that have historically done very well in education, they want to be told what to think and sometimes these [cognitive science-informed] approaches can be a bit more kind of exploratory, and they don't end up with beautiful kind of pages and pages of written work and some of the best learning is kind of discursive rather than written. And I think they would just be like 'miss, let's just write an essay'. (Interview 4)

In line with this, the interviewed teachers described the introduction of cognitive science-informed approaches as a process, by which the children would slowly get used to the strategies and eventually be able to apply themselves. Specifically, the teachers who were teaching older year groups, mentioned that the children might not have been introduced to these techniques in earlier years, and therefore there would be a period of adjustment:

> We need to build foundations, much like doing maths and English, we've got to be making sure we are constantly dripping these strategies, so it becomes second nature. . . If we consistently do it over time, hopefully we will be able to see a child coming through who naturally applies these skills. (Interview 6)

School Approaches and Dynamics

The interviewed teachers generally agreed that for cognitive science-informed approaches to have real impact, schools needed a consistent approach. A whole-school approach was seen as important for securing student familiarity and buy-in (as described above), but also to ensure that teachers understood and practiced the strategies in the same way. One of the key barriers to cognitive science-informed strategies being adopted by

schools was, in the views of the interviewees, other teachers' initial lack of buy-in or experience of using the strategies:

> I think in the beginning, I wouldn't say that many staff were necessarily against it, but like anything, where lots of changes are happening, it is just taking time and I guess the challenge is how quickly we have been able to implement it … Once staff realise and they give it a go, that's when you get staff buy-in because they see the progress students make. (Interview 11)

This quote illustrates the previously made point that schools are made up of teachers, who are differently positioned in relation to teaching, learning, innovation and change (Ball *et al*., 2012). The interviewed teachers generally considered the lack of buy-in and experience of other teachers as related to teacher training and continued professional development (CPD):

> Teachers have got to learn how children learn, how the brain develops and how that building of knowledge within the brain is going to enhance their learning. (Interview 7)

> The whole thing about teacher's CPD is crucial. It is not about necessarily the SLT saying we want you to do this, it is about putting everything in place for people to be able to discover things. (Interview 1)

Two of the teachers furthermore specifically expressed a desire to know what other schools were doing, as a way to learn from others through dialogue and exchange of ideas:

> I think some communities of practice would be really helpful. Because we only know what we are doing here. I have no idea what they are doing in the school up the road. That would be really powerful. (Interview 8)

Other teachers also mentioned the need for staff to support one another internally, for example by giving feedback or functioning as 'buddies.' This was perceived as an important way to avoid a top-down implementation of cognitive science-informed strategies by the senior leadership. However, in parallel to the wish for more training and dialogue between colleagues and schools, there was significant recognition that teachers very often have limited time available and that they are sometimes restricted by curriculum and timetable requirements:

> … teachers are time-starved, so you have to drip feed; it can't be massive changes in the way they teach. It's a slow change. (Interview 6)

> You might have wonderful ideas of what you want to implement in terms of teaching strategies, but then the curriculum and the curriculum time that you've got and the way the timetable is organised, can make that quite difficult. (Interview 2)

As these two quotes suggest, the opportunities of teachers to attend training, engage in inter-school dialogues or try out cognitive science-informed approaches in their classrooms to some extent depend on factors, external to the schools, such as for example the 'unusually long hours' that teachers in England work compared to their colleagues in other countries (Allen *et al*., 2021, p. 658) or the requirements of the English national curriculum. However, schools may vary significantly in the way they manage teacher workload and timetable the national curriculum, emphasising the dynamic interrelation between external factors, school approaches and dynamics, and their combined impact on teachers.

Teachers' Reflections on Outcomes

The interviewed teachers were generally positive about the effectiveness of the cognitive science-informed strategies they used in their teaching. This is perhaps not surprising given that the pool of survey respondents whom the interviewees were selected from, were also predominantly interested in and positive about cognitive science. Some of the teachers based their assessment of the strategies they used on their own evaluations of the work their students were producing, for example Teacher 8, who explained that:

> Test scores are getting better over time. The students are more able to talk about the strategy and the students are much more able to tell us what they learned last year. They are more detailed in their answers.

Another teacher explained that he had used a pre-bought programme with built-in quizzes to evaluate the impact of relevant strategies. However, across the interviews there still seemed to be some uncertainty about the process of assessing outcomes:

> We evaluate through student outcomes. We evaluate through learning, watching teachers, we track various pieces of data, but the challenge we've had is working out what to track and what not to track. And then the key part, the most important part is working out what to do with the information. (Interview 13)

Research on cognitive science-informed approaches often focus on measuring outcomes via short term or quantifiable tasks (Perry *et al*., 2021). However, as emphasised by one of the interviewed teachers, measuring learning outcomes is sometimes more complex:

> For me as a teacher and senior leader sometimes we were putting pressure on people to move too fast, to move the learning on. What we are saying now is that you can't really judge learning in a lesson anyway. How can you judge the

> learning in that class, because learning takes place over a period of time? (Interview 1)

Another teacher also commented on the narrow view of outcomes, pushed by external systems of accountability:

> The only things that are reported by the government are Math results, English reading, writing and grammar. Every school is going to want to get those grades in these as high as possible … if you are not making sufficient progress in those subjects, then that can trigger an Ofsted[2] inspection, so I think every head teacher, in my opinion, is very focused on these … the issue is we assess English, Maths and science rigorously, but we don't do the same in other areas to the same extent. (Interview 6)

The mention of Ofsted in this quotation highlights the importance of acknowledging how external factors, such as school inspections have come to define English teachers' and school leaders' views of what can be considered successful outcomes (Perryman *et al*., 2018). Whereas some of the teachers in our study described regular tests being carried out in their schools, they were not always sure that these were representative of what the students were learning, both because they were only carried out in certain subjects and because, as mentioned above, learning takes place over time. This illustrates some of the limitations of current testing regimes and emphasises the importance of acknowledging slow learning in both research and practice.

5. Discussion and Conclusion

Two main arguments can be derived from the interviews with the teachers in our study. First, there are a multitude of contextual factors involved in adopting cognitive science-informed strategies in schools and as the interviews suggest, any generic or 'easy' solutions may be limited in their applicability. Secondly, the diverse practical applications of cognitive science-informed approaches described by the teachers and their reflections on the use of such approaches for particular groups of children, subjects and settings, demonstrate the complex ways in which teachers enact cognitive science-informed approaches, as opposed to simply implementing them.

Ball *et al*. (2012, p. 21) have emphasised the importance of 'taking context seriously' when analysing policy enactment in schools. The findings from our study similarly show that different contextual dimensions are key to understanding how teachers enact (or not) cognitive science-informed approaches in their classrooms. The 13 schools represented in the interviews were characterised by very different contexts in terms of location, student intake, teacher

experiences, and school culture. When discussing their experiences of cognitive science-inspired approaches, the interviewed teachers often related them to their particular students and subjects. The teachers' negotiations with students from different groups illustrated well that teachers cannot simply apply a strategy in their classroom; they need to explain it to students, convince them that it is worth trying and challenge existing preconceptions about teaching and learning. In addition, strategies have to be supplemented by positive relationships with students and understandings of their home environment. In relation to specific subjects, teachers often perceived some as more or less 'naturally' aligned with cognitive science-informed approaches. However, the teachers were also showing an interest in learning from other subjects and exchanging experiences, highlighting the interactional and inter-disciplinary elements of teaching.

Seemingly in contrast to this recognition of diverse teaching and learning environments, a few teachers expressed a wish for 'shelf-ready' subject specific strategies which could be easily adapted to save time. Time was a key consideration for the interviewed teachers, illustrating that external and material factors, such as workload, teacher shortages (Sibieta, 2020) and spending cuts in schools (Granoulhac, 2017), all form an important context for teachers' ability to enact cognitive science-informed strategies in their classrooms and/or attending training to support them do so.

Teacher knowledge, training and CPD were described in our data as key supporting factors to the success of cognitive science-informed strategies, but some of the interviewed teachers also mentioned the importance of informal dialogue, staff support, and teacher autonomy, as opposed to being told what to do. Our interviewees furthermore emphasised the importance of teacher buy-in and gradually changing practices. Differences within and between schools were evident in the data and illustrate Ball et al.'s point that schools are not homogenous and de-contextualised organisations or 'undifferentiated wholes' (2012, p. 5). The introduction of cognitive science-informed strategies is thus not only a matter of practical implementation, but also a dynamic and political process, within which teachers are differently positioned.

A final important context hinted to in our data was the performativity of the current British educational landscape (Keddie, 2017; Perryman and Calvert, 2020). Ball *et al*. (2012) describe the 'pressures and expectations generated by wider local and national policy frameworks such as Ofsted ratings' as an important external context for policy enactment in British schools. In our study, Ofsted inspections were similarly mentioned by the teachers as influencing the practices and priorities of their schools. As described by several of them, only certain subjects (those reported by the government or inspected by Ofsted) were regularly being tested and it was therefore difficult to assess or

understand the effectiveness of cognitive science-informed strategies for other subjects or more holistically.

The multiple and varied contextual dimensions identified and discussed in this paper form an important background against which the benefits and challenges of cognitive science-informed strategies must be understood. The contexts interact with one another to shape different situations which teachers and students need to respond to. The dominant view of cognitive science as 'evidence' thus has to be combined with an acknowledgement that schools and teachers need to be given room and time to experiment with these strategies in ways that are appropriate for their particular subjects and sensitive and responsive to their students.

Howard-Jones *et al*. (2018, no page) note that:

> Although the science provides principles and a scientifically determined understanding of how learning works, based on concrete measurement of behaviour and brain function, it does not provide a list of 'top tips' or practices that are guaranteed to work with any class or individual in any context. In the absence of a one-size-fits-all prescription for effective teaching, teachers must constantly make decisions based on their own ideas of how learning proceeds and what they observe occurring in their classrooms.

In this paper, we have aimed to show some of the ways in which teachers make such decisions about when and how they draw on cognitive science principles in their classrooms, recognising that contextual dimensions such as the ones outlined in the paper will necessarily impact on their opportunities and confidence to do so. The practice-facing literature includes a lot of material which tries to 'sell' cognitive science to teachers and show how they may implement it, but much less information about how teachers understand, experience, and negotiate cognitive science in their own contexts. As we have illustrated in this article, cognitive science-informed approaches are not practiced in a vacuum and many inter-connected contexts both form the background for and respond to the enactment of these strategies within schools. Teachers therefore need more than 'recipes' describing particular strategies. They also need allocated time and resources to experiment and explore how different cognitive science-informed strategies might work best in their particular settings.

6. Disclosure Statement

No potential conflict of interest was reported by the author(s).

Funding

Education Endowment Foundation.

7. Supplementary Material

Supplemental data for this article can be accessed online at https://doi.org/10.1080/00071005.2023.2245438

8. Orcid

Clara Rübner Jørgensen http://orcid.org/0000-0001-8387-4819
Thomas Perry http://orcid.org/0000-0002-6124-467X
Rosanna Lea http://orcid.org/0000-0002-2309-0948

9. Notes

[1] A website set up by cognitive psychologists interested in research in education.
[2] The English inspectorate of Education.

10. References

Agarwal, P. K., Nunes, L. D. and Blunt, J. R. (2021) Retrieval practice consistently benefits student learning: a systematic review of applied research in schools and classrooms, *Educational Psychology Review*, 33 (4), 1409–1453. doi:10.1007/s10648-021-09595-9.

Allen, R., Benhenda, A., Jerrim, J. and Sims, S. (2021) New evidence on teachers' working hours in England. An empirical analysis of four datasets, *Research Papers in Education*, 36 (6), 657–681. doi:10.1080/02671522.2020.1736616.

The Ambition Institute. (2020) *Teacher Handbook* (London, UK, The Ambition Institute and the Department for Education).

Aronsson, L. (2020) Reconsidering the concept of difference: a proposal to connect education and neuroscience in new ways, *Policy Futures in Education*, 18 (2), 275–293. doi:10.1177/1478210319850437.

Ball, S. J., Maguire, M. and Braun, A. (2012) *How Schools Do Policy – Policy Enactments in Secondary Schools* (London, Routledge). doi:10.4324/9780203153185.

Churches, R., Dommett, E. J., Devonshire, I. M., Hall, R., Higgins, S. and Korin, A. (2020) Translating laboratory evidence into classroom practice with teacher-led randomized controlled trials – a perspective and meta-analysis, *Mind, Brain, and Education*, 14 (3), 292–302. doi:10.1111/mbe.12243.

Cukurova, M., Luckin, R. and Baines, E. (2018) The significance of context for the emergence and implementation of research evidence: the case of collaborative problem solving, *Oxford Review of Education*, 44 (3), 322–337. doi:10.1080/03054985.2017.1389713.

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B. and Osher, D. (2020) Implications for educational practice of the science of learning and development, *Applied Developmental Science*, 24 (2), 97–140. doi:10.1080/10888691.2018.1537791.

Deans for Impact. (2015) *The Science of Learning* (Austin, TX, Deans for Impact).

Department for Education. (2019) *Initial Teacher Training Core Content Framework* (London, DfE).

Dougherty, M. R. and Robey, A. (2018) Neuroscience and education: a bridge astray? *Current Directions in Psychological Science*, 27 (6), 401–406. doi:10.1177/0963721418794495.

Dunlovsky, J. and Rawson, K. A. (2015) Practice tests, spaced practice, and successive relearning: tips for classroom use and for guiding students' learning, *Scholarship of Teaching and Learning in Psychology*, 1 (1), 72–78. doi:10.1037/stl0000024.

Dunlovsky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J. and Willingham, D. T. (2013) Improving students' learning with effective learning techniques: promising directions from cognitive and educational psychology, *Psychological Science in the Public Interest*, 14 (1), 4–58. doi:10.1177/1529100612453266.

Goswami, U. (2006) Neuroscience and education: from research to practice? *Nature Reviews Neuroscience*, 7 (5), 406–413. doi:10.1038/nrn1907.

Granoulhac, H. (2017) Excellence at what cost? Austerity and the reform of the school system in England (2010–2016), *The Political Quarterly*, 88 (3), 434–442. doi:10.1111/1467-923X.12375.

Grospietsch, F. and Mayer, J. (2020) Misconceptions about neuroscience – prevalence and persistence of neuromyths in education, *Neuroforum*, 26 (2), 63–71. doi:10.1515/nf-2020-0006.

Howard-Jones, P. A. (2014) Neuroscience and education: myths and messages, *Nature Reviews | Neuroscience*, 15 (12), 817–824. doi:10.1038/nrn3817.

Howard-Jones, P., Ioannou, K., Bailey, R., Prior, J., Yau, S. and Jay, T. (2018) Applying the science of learning in the classroom, *Impact* (Chartered College of Teaching). https://impact.chartered.college/article/howard-jones-applying-science-learning-classroom/.

Keddie, A. (2017) Primary school leadership in England: performativity and matters of professionalism, *British Journal of Sociology of Education*, 38 (8), 1245–1257. doi:10.1080/01425692.2016.1273758.

Kitchen, W. (2021) Neuroscience and the Northern Ireland curriculum: 2020, and the warning signs remain, *Journal of Curriculum Studies*, 53 (4), 516–530. doi:10.1080/00220272.2020.1779350.

McMahon, K., Shu-Hua Yeh, C. and Etchells, P. J. (2019) The impact of a modified initial teacher education on challenging trainees' understanding of neuromyths, *Mind, Brain and Education*, 3 (4), 288–297. doi:10.1111/mbe.12219.

Ofsted. (2019) *Education Inspection Framework – Overview of Research* (Manchester, Ofsted).

Pampaka, M., Williams, J. and Homer, M. (2016) Is the educational 'what works' agenda working? Critical methodological developments, *International Journal of Research & Method in Education*, 39 (3), 231–236. doi:10.1080/1743727X.2016.1170476.

Pashler, H., Bain, P., Bottge, B., Graesser, A., Koedinger, K., McDaniel, M. and Metcalfe, J. (2007) *Organizing Instruction and Study to Improve Student Learning (NCER 2007-2004)* (Washington, DC, National Center for Education Research, Institute of Education Sciences, U.S. Department of Education). http://ncer.ed.go.

Perry, T., Lea, R., Jørgensen, C. R., Cordingley, P., Shapiro, K. and Youdell, D. (2021). *Cognitive Science in the Classroom* (London, Education Endowment Foundation (EEF)). The report is available from: https://educationendowmentfoundation.org.uk/evidence-summaries/evidencereviews/cognitive-science-approaches-in-the-classroom/.

Perryman, J. and Calvert, G. (2020) What motivates people to teach, and why do they leave? Accountability, performativity and teacher retention, *British Journal of Educational Studies*, 68 (1), 2–23. doi:10.1080/00071005.2019.1589417.

Perryman, J., Maguire, M., Braun, A. and Ball, S. (2018) Surveillance, governmentality and moving the goalposts: the influence of Ofsted on the work of schools in a post-panoptic era, *British Journal of Educational Studies*, 66 (2), 145–163. doi:10.1080/00071005.2017.1372560.

Putnam, A. L. and Roediger III, H. (2018) Education and memory – seven ways the science of memory can improve classroom learning, chapter 6. In E. A. Phelps and L. Davachi (Eds) *Stevens' Handbook of Experimental Psychology and Cognitive Neuroscience, Learning and Memory* (New Jersey, USA, John Wiley & Sons, Incorporated), 1–45. doi:10.1002/9781119170174.epcn106.

Riccomini, P. J. and Morano, S. (2019) Guided practice for complex, multistep procedures in algebra scaffolding through worked solutions, *TEACHING Exceptional Children*, 51 (6), 445–454. doi:10.1177/0040059919848737.

Richens. (2021) *Essential Guides for Early Career Teachers: Using Cognitive Science in the Classroom* (St Albans Herts, UK, Critical Publishing).

Rosenshine, B. (2010) Principles of instruction. In H.J. Waldberg and S. J. Paid (Eds) *Educational Practice Series* (vol. 21) (Brussels, Belgium, International Academy of Education), 6–28.

Sibieta, L. (2020) *Teacher Shortages in England – Analysis and Pay Options* (London, Education Policy Institute).

Thomas, M. S. C., Ansari, D. and Knowland, V. C. P. (2019) Annual research review: educational neuroscience: progress and prospects, *Journal of Child Psychology and Psychiatry*, 60 (4), 477–492. doi:10.1111/jcpp.12973.

Tommerdahl, J. (2010) A model for bridging the gap between neuroscience and education, *Oxford Review of Education*, 36 (1), 97–109. doi:10.1080/03054980903518936.

Weinstein, Y., Madan, C. and Sumeracki, M. A. (2018) Teaching the science of learning, *Cognitive Research: Principles and Implications*, 3 (2). doi:10.1186/s41235-017-0087-y.

Correspondence
Clara Rübner Jørgensen
Department for Disability Inclusion and Special Needs,
School of Education University of Birmingham,
Birmingham B15 2TT, UK
Email: c.joergensen@bham.ac.uk