Cognitive Load Theory and teacher expertise: specific challenges for primary teachers

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Context

Cognitive Load Theory (CLT) (Sweller, 1998) is a well-established framework that has attracted renewed attention due to its evidential role in the new Ofsted Education Inspection Framework (Ofsted, 2019). CLT concerns the architecture of memory - how the brain processes and stores information. All conscious processing occurs in the working memory which has limited capacity, whereas long-term memory can store a limitless number of schemata – multiple elements of information combined into a single representation (schema) with a specific function. For example, a young child may develop a schema for a flower; they know that it has colourful petals and might have a pleasant fragrance. As they learn more, the schema is modified to accommodate new information that the flower is a part of a plant, which also has a stem, leaves and roots. Each time they encounter a plant, this schema is retrieved automatically by the brain as it categorizes incoming information. The complexity of the schema will develop as the child encounters new varieties of plant in different contexts. A schema can be processed efficiently as one element by the working memory, making it quicker, less effortful and more automatic.

Cognitive load is the amount of information processing required to perform a task (Reif, 2010) and CLT identifies three forms (Chandler and Sweller, 1991; Paas, Renkl and Sweller, 2003). Intrinsic cognitive load is the inherent difficulty and complexity of the material being learned and is influenced by prior knowledge. Design of learning sequences and activities can also impose cognitive load. Where this load is unnecessary – extraneous cognitive load - it interferes with schema acquisition and automation. In contrast, when information is presented in ways which support information processing and promote schema development (e.g. careful sequencing, use of modelling), these helpful elements contribute germane cognitive load. Germane load is treated differently by different researchers. For example, although they initially saw it as being part of the overall cognitive load, Sweller et al's (2019) recent review instead suggests that germane load redistributes working memory resources from extraneous activities to learning-relevant activities. Kalyuga (2011), meanwhile, focused on just two types of cognitive load: intrinsic and extraneous.

Where intrinsic CL and extraneous CL are both high, they can exceed the processing capacity of the working memory, affecting learning outcomes negatively. CLT offers a framework through which teachers can consider the design of learning, orientating learners to schema development and automation before they are required to use schemata for inquiry or problem-solving applications.

Application of CLT is not simply about minimising cognitive load or teaching via tightly-prescribed methods, though. If formulaic responses by teachers are to be avoided, considerable expertise is required to enact nuanced judgements with the aim of optimising learners' cognitive loads. In the course of my work as a teacher educator, considering how to introduce novice teachers to the key principles of CLT prompted a major pause for thought about the inherent and specific challenges for primary teachers.

Demands on teachers' knowledge

Germane CL and extraneous CL can be modified through the teachers' pedagogical choices but involves more than simplifying instructions and decluttering PowerPoint slides. Careful selection is required of only the most pertinent concepts and ideas, optimally sequenced to best support learners' acquisition of schemata. It is logical to deduce that teachers themselves will need well-developed conceptual frameworks of the subject matter to do this successfully. Knowing how to select, construct and model the most purposeful examples, illustrations and analogies to aid learners' understanding depends on secure subject-specific pedagogical content knowledge (PCK) (Shulman, 1986). Deciphering cues from learners, such as spotting their errors or misconceptions, enables the teacher to assess learners' prior knowledge and understanding. Responding contingently draws upon complex, integrated professional knowledge.

Handling such intricacy is taxing for any novice teacher but for those learning to teach in the primary phase, it can be especially daunting. CLT acknowledges that intrinsic CL imposed by the innate difficulty of the material might be lessened by prior knowledge. Unlike most secondary teachers, primary teachers have not initially studied to an advanced level many of the subjects that they teach. The contrasting nature of less familiar disciplinary knowledge structures presents further complexity (e.g. hierarchical conceptually-based structures compared with more linear language-based structures). There is much to grapple with. Whilst experienced primary teachers might develop subject matter proficiency across the full breadth of the curriculum over time, the sustained effort and commitment involved should be acknowledged. It would be complacent to assume that all primary teachers in the early stages of their career have formed complex schemata associated with all relevant subject matter. When combined with their emergent pedagogical knowledge development, the ramifications become clearer.

Implications

When mentoring novice teachers, reflective dialogue following observations of their teaching frequently uncovers the source of problematic aspects of a lesson to be related to not having anticipated the relative ease or trickiness of concepts and ideas in the lesson material for the age and experience of the children. Often this is connected to novices making assumptions about learners' prior understanding, or omitting key vocabulary, skills, strategies or stages in thinking that are essential to successful learning outcomes. Similarly, children's common errors or misconceptions might not always be recognised or, if identified correctly, not necessarily broached as an opportunity for responsive teaching. Altogether, these areas of teacher learning require the development of complex schemata for how to translate subject matter into a teachable form (PCK) combined with general pedagogical knowledge to manage and direct the learning process in context. This is a work in progress for beginning primary teachers. The added complication of having to rely on their own sometimes incomplete, simplified or under-developed schemata of the subject matter knowledge itself, can impose a relentless demand on novice primary teachers for every episode of teaching. The perennial concern of trainees is 'Will this get easier?'

Expert teachers and novices

Examining the differences between the knowledge structures and automaticity of experts and novices further illuminates the difficulties, casting doubt on whether it is feasible for early career primary teachers to implement CLT effectively. Sternberg and Horvath (1995) identified three prototype features of expert teachers relating to their knowledge, efficiency and insight. Expert teachers are sensitive to the deep knowledge structures and the underlying principles of the problems they solve, whereas novices focus on surface structures. Elaborate schemata enable expert teachers to process information more efficiently, making their pedagogical practice seem effortless. Experts show deep insight into particular situations, allowing immediate distinction between relevant and irrelevant cues in learning contexts. Information processing performed with little or no conscious awareness, imposes minimal cognitive load and represents automaticity (Moors and De Houwer, 2006). Aligned with CLT, expert teachers will experience lower intrinsic CL due to the depth of their prior knowledge, their pedagogical design is orientated towards enhancing germane CL and they can process more extraneous CL without detriment (Sweller, 1998). Analysis suggests that the key principles of CLT are readily embedded into expert teachers' pedagogical practice, indeed they are perhaps implicit.

Unlike experts, intrinsic CL will be high for novice primary teachers for subject matter of which they have limited prior knowledge, in addition to their emergent subject-specific pedagogical knowledge

(PCK). Much of their information processing regarding pedagogical decision-making is likely to occur in the working memory, rather than via retrieval of robust, complex schemata from long-term memory due to variable depths of subject knowledge. Processing is conscious and effortful. Additionally, the dynamic demands of classroom practice impose extraneous CL. When this is enacted within a performance culture (Ball, 2013) of regular lesson observations and assessment against professional standards, especially pertinent to trainee teachers, it is clear that novices' own cognitive loads are likely to be excessive. Feeling overwhelmed is a common experience.

If novice teachers find themselves in a situation in which they are cognitively overloaded, they may rely on 'fast and frugal' strategies (Feldon, 2007). From my own research examining beginning primary teachers' orientations towards subject knowledge (Pope 2019a), in-depth interviews uncovered varied attitudes, practices and influences, but many individuals admitted to using piecemeal strategies to get by from lesson to lesson. Hastily retrieved research prior to teaching and uncritical dependence on commercial schemes and resources, left them relying on simplistic or incomplete schemata to inform their practice. In some cases, the novices believed that this was a true representation of how all primary teachers work. The difficulty is that the effortless, unconscious processing and decision-making of an expert teacher is not made visible through observation. CLT focuses attention on the need to make explicit to novices, what is implicit to experts.

Reorientating early professional development

Teacher educators involved with mentoring trainees and early career teachers might consider adopting some professional development approaches that have the potential to shift information processing from working memory where CL is high, to building schemata to promote a higher degree of automaticity around key pedagogical thinking and action. Here are some ideas:

- Create shared knowledge maps of key concepts/ideas underpinning units of work across the curriculum. Focus attention on logical sequencing and highlight connections within, and between, subject topics. Regular revisiting during planning and preparation helps to develop mental models of the subject matter.
- Build 'case' knowledge through shared deconstruction and analysis of teaching and learning episodes. Make explicit the teacher's decision-making processes, drawing especially on PCK. A research-informed framework for cases with deconstructed examples across the primary curriculum is offered by Pope (2019b), for a scaffolded starting point. Build your own case studies from real examples. Perhaps ask your mentee to present a case to you for discussion as the basis for a coaching session dialogue.

- Engage in co-planning and co-teaching with novice teachers to reduce their cognitive overload through carefully-defined and managed foci. The accompanying dialogue opens up the hidden elements of each other's thinking, whilst enabling legitimate participation. Discussion needs to be scaffolded; you can suggest a menu of question prompts for mutual consideration to avoid defaulting to the generic.
- Use collaborative practitioner enquiry (e.g. the Lesson Study approach) to plan, implement and evaluate targeted interventions, expanding pedagogical discussions in the process.

Approaches like these take the emphasis away from novices trying to demonstrate their competence in keeping all the pedagogical plates spinning by whatever means, instead focusing on developing more elaborate schemata for underpinning knowledge and understanding. Encouraging the pre-cursors for less effortful information processing for key pedagogical elements provides firmer foundations for developing future expertise. In this sense, CLT provides a useful exploratory lens through which to consider the professional development needs of novice primary teachers and the design of learning experiences.

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