

Teaching for learning transfer: A literature review

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A literature review for the
Victorian Curriculum and
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Developing capabilities across the curriculum involves building capacity to transfer learning from one context to another. The VCAA commissioned this literature review in 2018 to identify understandings of learning transfer, its importance and how to improve teaching for learning transfer.

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TEACHING FOR LEARNING TRANSFER

Broadly speaking, 'learning transfer' is the ability to recognise what has been learned in one context and to apply and extend that learning in another context (Haskell, 2001)¹. Some assume that learning transfer will take care of itself. Our review of the literature seeks to understand why or why not this might or might not be the case and how to ensure teaching for learning transfer is not left to chance.

Michelle Anderson and Adrian Beavis²

1. Introduction

For more than a century, the concept of 'learning transfer' or the 'transfer of learning' or 'transfer' has been the topic of research and commentary (Barnett & Ceci, 2002; Haskell, 2001; Schwartz, Bransford, & Sears, 2005). For a while it became part of general cognitive theories where transfer was only indirectly considered (Salomon & Perkins, 1989 p. 114), but it has again re-emerged as a distinct field of study.

The Victorian Curriculum and Assessment Authority's (VCAA) interest in commissioning this initial review of the learning transfer literature stems directly from the VCAA's design of the Victorian Curriculum F-10. This curriculum design presumes knowledge and skills transfer across the curriculum. As the Victorian Curriculum website³ states in part:

*It is expected that the skills and knowledge defined in the capabilities will be developed, practised, deployed and demonstrated by students in and through their learning across the curriculum.*⁴

The task for this initial review was to identify understandings of learning transfer, its importance and how to improve teaching for learning transfer. Of particular interest to VCAA was the learning transfer literature's reference to one of the capabilities, critical and creative thinking (CCT) and the role it does and can play in promoting learning transfer. (VCAA organises CCT thinking and learning through the capability's three strands – Questions and Possibilities, Reasoning and Meta-Cognition) (Appendix 1 presents a description of the strands).

1.1 Search

We began our search of the literature using the Education Resources Information Center (ERIC) and Google Scholar databases and the obvious terms of 'transfer of learning', 'learning transfer' and 'transfer'. From these search results we identified other terms in use, such as 'knowledge transfer', 'transferable skills'. From the vast literature, we focused largely on the research literature that looks at schools and related educational settings, also checking the reference lists of these selected sources. In addition, because of the task for this review, we spent time reviewing the VCAA's CCT materials.

¹ Haskell writes: "Research for this book included the transfer of learning over the past 99 years in the field of education, cognitive psychology, business, industrial training, and from other related fields, including applied and theoretical research on analogical transfer ... this book integrates transfer of learning as it's used in education, business, and industry" (Haskell, 2001, p. xix).

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³ <https://victoriancurriculum.vcaa.vic.edu.au/overview/curriculum-design/learning-areas-and-capabilities>

⁴ Quoted from: <http://victoriancurriculum.vcaa.vic.edu.au/overview/curriculum-design/learning-areas-and-capabilities>

1.2 Structure

This review begins by providing a basic definition of learning transfer and a discussion of what makes it important. As we do this, we draw attention to key links between learning transfer and other relevant concepts (e.g. self-efficacy). In addition, we identify notable frameworks and mechanisms for thinking about learning transfer. Next, we identify what the research tells us about what does and can enhance the transfer of learning. Then we turn to some of the explicit challenges associated with teaching for transfer. The review concludes by drawing attention to where there appear to be key areas of consensus and opportunities for improving teaching for learning transfer.

2. Understanding what learning transfer is and its value to learners

As we indicate at the start of this review, put simply, learning transfer occurs when we apply our past learning to help learn something new (in situations that may be similar or different) (Haskell, 2001). This is consistent with the etymology of the word, transfer, which comes from the Latin ‘trans’, meaning ‘across’ or ‘over’ and ‘ferre’, meaning ‘to bear’. Together, they create the word, transfer – ‘to carry over’ (Haskell, 2001). This is consistent with an aspect of the Victorian Curriculum F-10 design. It expects learners will get opportunities to deploy – that is, learners can use, for example, a capability when needed, in and through the Learning Areas. This simple meaning of the term provides a relatively straightforward starting point for understanding the notion of ‘learning transfer’.

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The literature, however, is a complex web of different theories and conflicting views about the importance of learning transfer, its full and proper meaning, and how to teach to support learning transfer skills or dispositions (Schwartz et al., 2005, p. 3). Some argue that transfer of learning is a core instructional goal (see, for example, Mayer, 2002), while others claim it is impossible to teach because it is unworkable (Carragher & Schliemann, 2002). Whereas, Schunk (2012, p. 24) asserts: “Transfer lies at the heart of our system of education”.

Other researchers have an issue with the theories of transfer as they exist. Some argue that theories explain the learning of experts, but not of novices (Bransford & Schwartz, 1999). While other researchers express dissatisfaction with using transfer as a metaphor to imply that this is how learning works (Hager & Hodkinson, 2009). This metaphor, these researchers assert, sees ‘knowledge’ as ‘a thing’ to be carried about (“moved from place to place”) by the individual (Hager & Hodkinson, 2009, pp. 11, 15-16). This becomes a narrow lens for understanding the transfer of learning. It can diminish, de-couple or ignore altogether the role and influence of the learner, contexts and settings in which teaching and learning takes place. Similarly, other research implies we should take care with the use of overly optimistic expectations of learning transfer views and the teaching for it (Margulieux & Catrambone, 2019).

These types of views influence how we think about the transfer of learning and have implications for how teachers plan and teach for learning transfer.⁵

What follows is a discussion of some of the themes and frameworks for thinking about learning transfer. Together, they inform and link to understandings of learning transfer, its role and importance, usefulness and the teaching for 'it'.

2.1 Theme: Becoming life-long learners

Some theorists maintain that learning transfer refers to a broad conception of learning that is more an orientation, predisposing people to want to learn and keep learning. These theorists argue learning transfer is better seen as a habit of mind rather than an instructional technique (Bereiter, 1995; Haskell, 2001). Some argue this view expands the metaphor of transfer from a discrete series of "acquisition events" to it being seen as an "ongoing process" of 'boundary crossing' transitions (the physical or social crossing from one location to another – for example, school to a workplace) (Hager & Hodkinson, 2009, pp. 2, 10). Hager and Hodkinson propose that a better metaphor to use is 'becoming'. They write:

... people become through learning and learn through becoming whether they wish to do so or not, and whether they are aware of the process or not. (Hager & Hodkinson, 2009, p. 13)

As Lucas (2019, p. 4) observes, these:

Capabilities and capability-like aspects of performance – dispositions, attributes, habits of mind and competencies – have been gaining traction in school systems for some two decades.

These broad views link learning transfer to the concept and role of 'motivation' (see Haskell, 2001) and the influence this can have on learners' engagement in their learning, their attempts at initiating transfer and persisting (Pugh & Bergin, 2006). In turn, this then also links to the concepts of 'self-efficacy'⁶ and 'creative self-efficacy' (Beghetto & Karwowski, *in press*), and to the notion of a 'growth mindset' (Claro & Loeb, 2017).⁷ These concepts, can manifest in a learner's increased confidence⁸ to achieve a specific task, as well as her or his belief they can act and make choices.

For some writers, this is where they see learning transfer as pivotal to the development of student agency and decision-making within school settings (Schwartz et al., 2005). This in turn has important learning outcomes for students. There is good evidence that when levels of student agency increase, this produces improved learning experiences and outcomes for students (Annan, 2016; Ferguson, Phillips, Rowley, & Friedlander, 2015; Kohimarama School, n.d.; Vaughn, 2014). Others also note that as students' agency increases, so too does their curiosity and engagement in their communities (United Nations Department of Economic and Social Affairs, 2016; Williams, 2017).

⁵ We focus this review on learning transfer literature, but do so acknowledging and recognising that learning and learning transfer are inextricably linked (Gordon & Doyle, 2015). Teachers and how they teach matters to both learning and learning transfer. For more on student learning and on teachers knowing their impact, see the internationally esteemed and significant body of work from Professor John Hattie, University of Melbourne.

⁶ Self-efficacy is what an individual believes they can do (see, for example, Bandura (1994) and Rose (2017)). Self-efficacy is context and task specific.

⁷ Claro and Loeb (2017) characterise a 'growth mindset' as a belief that one's capabilities can change and improve.

⁸ Thompson and co-authors' (2003) qualitative study found that there was evidence of transfer of skills and knowledge for students enrolled in a distance education course in human resource development; and that among the findings, this was accompanied by reported increased confidence for students.

When learning transfer is understood in these ways, it becomes an essential ‘habit’ for life (Pratzner, 1978, cited in Haskell, 2001). For these writers, learning transfer extends well beyond the context of schooling (Halpern & Hakel, 2003; Perkins & Salomon, 1992), and links to employability and effective citizenship (Gordon & Doyle, 2015; Haskell, 2001; Raaijmakers et al., 2018).⁹ The importance of this is picked up by Haskell (2001, p. xiii). He points out how “employers lament students’ inability to use what they have learned” and goes on to stress the importance of learning transfer, noting that the more the ‘habit of transfer’ develops, “the more creative and efficient is our thinking and performance” (Haskell, 2001, p. 24). This can include, for example, the transfer of basic skills, such as reading and mathematics, as a routine aim for schools (Collins, 2018). Being able to transfer learning prepares students for reading texts for other purposes (e.g. job applications, contracts, wills) and everyday numeracy applications (e.g. supermarket and online shopping). Others argue, this in turn requires providing authentic opportunities for learners to use their learning in their lives, and believe that what they are learning is important and of value (Gordon & Doyle, 2015).

These understandings of learning transfer draw attention in the literature to this concept’s dynamic relationship between learners, learning, setting and context.

2.2 Theme: Critical and Creative Thinking (CCT) capability

CCT capability appears in much of the learning transfer literature over a sustained period of time. Illustrative of this is the term ‘transfer’ and its feature in early literature on the instruction of critical thinking (and the related concepts of ‘reasoning’ and ‘problem-solving’) (See Ellis, 1965 and McKeachie, 1986 cited in Haskell, 2001; Bereiter, 1995). From here, it is a short step to ‘metacognition’ and the role of such metacognitive skills as self-monitoring and self-regulation in facilitating learning and transfer (Larsen-Freeman, 2013; Raaijmakers et al., 2018).

To inform their experimental design study with Year 8 students in a Netherlands secondary school, Raaijmakers and colleagues’ literature review identifies that these sorts of self-regulation knowledge and skills are learnable and associated with better student academic achievement across childhood and adolescence (Dent & Koenka, 2016, cited in Raaijmakers et al., 2018). From their review of the literature, they note the pivotal processes of self-regulated learning in preparing students for post-secondary school pathways. Drawing on the work of others, they frame these processes as students monitoring (during performing a task), either retrospectively (self-assessment of a completed task) or prospectively (estimating future performance on a similar task); and control (the learner adjusting his or her current behavior) (Raaijmakers et al., 2018).

Similarly, Schwartz (2005, p. 13) references transfer alongside the concept and practice of learners learning how to learn. While, for some, learning transfer is seen as the ultimate aim of teaching (Bereiter, 1995; Bransford & Schwartz, 1999; Haskell, 2001) because it is foundational to learning, thinking and problem-solving (Broad & Newstrom, 1992, cited in Haskell, 2001).

⁹ Despite this importance, as Fleishman (1987) notes, there appears to be a surprising lack of attention to learning transfer.

More broadly, the relevance and need for key capabilities is gaining momentum. Evidence of this on the international ‘stage’ is the World Economic Forum (2016)¹⁰ recognising CCT capability as one of the most important capabilities for employability. Similarly, the importance of this capability is reflective in the OECD’s Centre for Research and Innovation (2018)¹¹ conducting research across 14 countries into how best to enable and assess CCT. While in 2021, for the first, the Programme for International Student Assessment (PISA)¹² will test ‘creative thinking’. At play behind these calls are such forces as globalisation, job disruptions across every sector, workplaces constituting people working together across multiple generations, and the rapid pace of change.

So too does the Victorian Curriculum F-10 reflect the importance of CCT capability, among other capabilities. Its design, as we note earlier, expects learners’ CCT capability, and its thinking processes collectively (see below), to be applied across the curriculum and thus play a role in the transfer of learning:

Critical and creative thinking capability aims to ensure that students develop:

- understanding of thinking processes and an ability to manage and apply these intentionally;
- skills and learning dispositions that support logical, strategic, flexible and adventurous thinking;
- confidence in evaluating thinking and thinking processes across a range of familiar and unfamiliar contexts.

The linkage across to learning transfer can be seen in the Victorian Curriculum’s reference to the application of thinking processes, the learning of dispositions that support (adventurous) thinking and the carriage of good thinking across a variety of contexts.

Even those who see learning transfer as less fundamental, see it as important. Cultivating capabilities is said to assist people to think, reason, plan and make good decisions to cope and adjust to the world (Haskell, 2001). They are core within the teaching, especially of CCT’s reasoning and meta-cognition strands.

The above themes suggest that learning transfer is important within schools, in assumptions underpinning school curricula and for developing life skills outside of school.

2.3 Frameworks and mechanisms for thinking about learning transfer

As one might expect from a century worth of research and commentary, different frameworks and mechanisms for thinking about ‘learning transfer’, ‘the transfer of learning’ or ‘transfer’ permeate the literature (Barnett & Ceci, 2002; Haskell, 2001; Schwartz, Bransford, & Sears, 2005).

Wardle (2007, pp. 67-68), for example, argues that there are three main approaches to defining the term transfer:

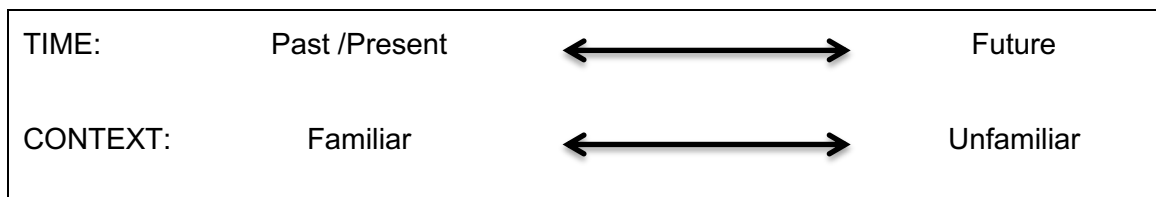
¹⁰ See <https://www.weforum.org/agenda/2016/02/what-skills-do-graduates-need-to-get-a-job/>

¹¹ See <http://www.oecd.org/education/ceri/assessingprogressionincreativeandcriticalthinkingskillsineducation.htm>

¹² See <https://connecme.actclub.org/2018/09/oecd-selects-act-to-develop-pisa-2021-creative-thinking-assessment/>

1. 'Task' conceptions, which focus upon the transfer of skills across different but related tasks.
2. 'Individual' conceptions, which focus upon the predispositions of individuals towards 'learned intelligent behavior'. (The issue of metacognition is probably subsumed within this approach.)
3. 'Context' conceptions, which place an emphasis upon the learning contexts rather the individual.

Notable, though, among the research on learning transfer is the influential work of Salomon and Perkins (1988, 1989, 1992). Much of the more recent framing, citing or elaboration of learning transfer in the literature appears to come from their thinking and research. From their work, two ways (mechanisms) for thinking about learning transfer when teaching for it are:



Box 1: Two ways for thinking about learning transfer

- Time – a series of moments from a learner’s past, present, future.
- Context – settings, situations, opportunities, experiences (as we elaborate below and later in this review, a challenge in teaching for learning transfer is remembering that what might be a familiar context to one learner, could be quite unfamiliar to another learner).

In framing thinking about learning transfer in this way, Salomon and Perkins shine a light on ‘how transfer occurs’.

For Perkins and Salomon (1988), there are two main types of similarity – ‘low road’ and ‘high road’. Each they associate with different approaches to help students recognise similarities between two settings or problems.

Low road transfers involve, “automatic triggering of well-practiced routines in circumstances where there is considerable perceptual similarity to the original learning context” (Perkins & Salomon, 1988, p. 25). An example used by Perkins and Salomon is learning to drive. Having learned to drive a car, a person might take their understanding of the routines of driving a car and apply these to learn to drive a truck. Whereas, high road transfer involves finding purely abstract or conceptual similarities between old and new contexts or problems (Perkins & Salomon, 1988).

In a later paper, Salomon and Perkins (1989) develop their ideas further, suggesting that it is too much to ask for a theory of transfer to predict specifically ‘what will transfer to what’. In any case, they argue, such an approach is not desirable. They provide four arguments for these views:

- **First**, Salomon and Perkins argue that judgements about the similarity of contexts will be influenced by “what sorts of transfers are common-place” (Salomon & Perkins, 1989, p. 137). There is, in other words, no easy way to describe the similarity or dissimilarity of contexts.

- **Second**, and applying a similar argument to the first, they argue that it is difficult to describe the extent to which two performances are similar or dissimilar (Salomon & Perkins, 1989, p. 138). Without this information, it is impossible to describe what has (or has not) been transferred.
- **Third**, they argue that high road transfers are “a highly constructive act of mind” (Salomon & Perkins, 1989, p. 138). This makes understanding the connections people might make between contexts very difficult (and even more difficult for teachers to predict).
- **Fourth**, they argue that measuring ‘what will transfer to what’ is impossible. It is impossible because, as they claim, “Transfer relations do not obey some elementary requirements for a proper metric” (Salomon & Perkins, 1989, p. 138).

This approach by Salomon and Perkins means that they could separate the ‘how’ of transfer from the ‘what’. By focusing on the ‘how’ they were able to formulate their high and low road notions of transfer. This also allowed them to see transfer as either ‘backward-reaching’ or ‘forward-reaching’.

Backward-reaching means the learner, when facing a new situation or problem, “deliberately searches for relevant knowledge already acquired” (Salomon & Perkins, 1989, p. 113). A real-world example of this, we suggest, might be learning to ride a bicycle by deliberately searching back to retrieve and apply what you already learned from riding your tricycle as a child. Fuchs et al. (2017) added to this understanding of low road transfer, which they state is “accomplished using extensive, varied practice; it occurs as a function of the automatic triggering of well-learned, stimulus-controlled behaviour in a new situation” (p. 293).

In forward-reaching, high road transfer, the learner applies concepts or principles in anticipation of them being used in the future (Salomon & Perkins, 1989, p. 113). We suggest a curriculum example of this might be a student learning how to draft a piece of persuasive writing in English and recognising how the concept of being persuasive might also be helpful to them when, for example, trying out for the school’s debating team or when convincing a prospective employer to give them the job. Drawing on the work of Salomon and Perkins, Fuchs et al. (2017) argue that teachers can promote forward-reaching transfer by, for example, formulating the scientific factors relevant to electricity and highlighting how these principles apply to other domains of science. (Some research literature reports that the teaching of principles and the use of such strategies as analogies and metaphors can prompt and cue learners’ transfer of learning. We expand on this in the next section of the review.)

To summarise, Salomon and Perkin’s framing involves learners retrieving and applying their learning in familiar and unfamiliar contexts, and at times, in anticipatory - “forward-reaching” - ways (see Table 1).

<p>High road backward-reaching: Learner deliberately searches for relevant knowledge from what they have already learned and draws on this when facing a new situation or problem.</p>	<p>High road forward-reaching: Learner applies concepts or principles in anticipation of using these in the future.</p>
<p>Low road transfer: Learner triggers well-practiced routines in a circumstance where they perceive there is ample similarity to the original learning context.</p>	<p>Low road transfer forward-reaching: In a new context with considerable similarity to the original learning context, the learner automatically uses well-practiced routines.</p>

Table 1: A framework for thinking about learning transfer, adapted from Salomon and Perkins, 1988, 1989, 1992.

Their research led them to a set of what they called ‘richer questions’ about learning transfer:

- What encourages abstraction?
- What encourages reaching back for potentially applicable elements from prior learning?
- What metacognitive habits does the person bring to the occasion that would help high road transfer?
- Concerning the low road, is the practice sufficient to yield automatisisation?
- Does a performance lend itself to low road, or high road transfer, or both roads, and if so how? (Salomon & Perkins, 1989, p. 139).

Despite the differences or differences in emphasis, most writers see learning transfer as important. The next section identifies what the research tells us about what does and can enhance the transfer of learning.

3. Enhancing learning transfer

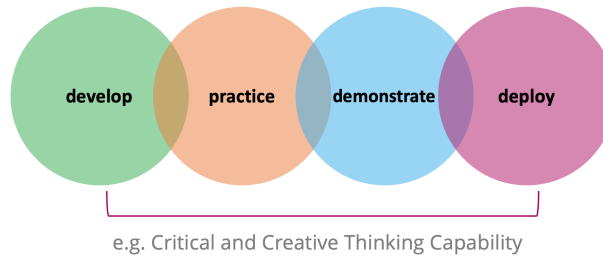
Some might assume the transfer of learning will take care of itself. The literature is clear, it will not. If learning transfer is important, then how do teachers best cultivate it? Unsurprisingly, there are a variety of answers to this question. Our review presents the most convincing of those answers (based on the quality of supporting evidence, arguments, or both).

This section covers what teachers do or can do to create the conditions for enhancing learning transfer (cultivate) and how teachers do or can use key strategies to promote the transfer of learning (build).

3.1 Teacher lesson planning considerations

A key message across the learning transfer literature is to explicitly embed the notion of transfer in pedagogy. Learning and transfer of learning are inextricably linked (Gordon & Doyle, 2015). Both are required for successful educational outcomes. The VCAA Curriculum F-10 design is reflective of this thinking. As we note earlier, its curriculum design expects teachers will plan to:

Create opportunities for students to:



Gordon and Doyle (2015) argue that it is important that transfer of learning is made explicit and upfront in the design of learning programs. They examined various studies of a personal and social responsibility program. One successful practice was for teachers to discuss the idea of transference upfront with the (secondary school) students, from the first session onwards. (This suggests that teachers too need to understand and value the use of teaching for learning transfer.)

At a classroom level, finding out what students are bringing to a situation as they begin their learning (that is, recognising prior learning) is a key pre-cursor for transfer. From his analysis, Haskell (2001) asserts a 'large knowledge base' is fundamental to effective transfer. Similarly, in a short but focused review of the research literature, among their conclusions, Bransford and Schwartz (1999, p. 64) suggest that it has now been established that:

The effectiveness of transfer is dependent upon the quality of existing prior knowledge. Students need to build upon what is already known to transfer their learning.

From a later theoretically guided review of evidence, Schwartz and colleagues (2005) conclude that an approach which addresses questions about 'what gets transferred' focuses on forms of knowing associated with direct application (or, replication and application). This, they argue, means that transfer is seen as something that happens 'afterwards' (that is, there is a transfer 'out'). The authors also claim it is important to pay attention to what learners bring to a situation (for example, their mental models and preconceptions), as well as what they may transfer out. In other words, students transfer *in* to a learning situation, and teachers need to be aware of what they are bringing with them. The authors summarise their views as follows:

The ways and interpretations that people transfer in can have major effects on their learning and subsequent abilities to 'transfer out' from that learning (Schwartz et al., 2005, p. 11).

Other writers tackle some of these, and related, issues. For example, Bereiter (1995) argues that successful transfer occurs when the learner possesses the dispositions, knowledge, strategies and processing skills relevant to the targeted transfer task. This view recognises the importance of the strengths a learner may bring to a task or develop through a task. This approach shows the links between transfer as 'habit of mind' and the importance and relevance of a learner's 'self-efficacy', 'creative self-efficacy' and 'agency'. It also offers, in part, an explanation for why there is the need to teach capabilities explicitly, such as 'critical and creative thinking' and 'personal and social capability' in the Victorian curriculum. Both these capabilities connect to this notion of 'habit of mind'.

Larsen-Freeman (2013) also looks at teacher lesson planning considerations, but from the transfer of learning in second language learning. From her review, Larsen-Freeman is also led to conclude that teaching for transfer is a much more dynamic process than the simple carrying over of learning to a new situation. In reference to studies of second language writing skills, she observes that students play an active role in constructing knowledge (applying *and* reshaping) as they interact with different and changing contexts. From a complexity theory perspective, Leather and van Dam make the point that “linguistic knowledge is not given or transferred but adaptively achieved by the individual in the environment” (Leather & van Dam, 2003, cited in Larsen-Freeman, 2013, p. 119).

3.2 Applying frameworks for thinking about learning transfer in the classroom

It is widely agreed that transfer can be made easier when people perceive there is similarity between the original learning context and a new one (Haskell, 2001; Perkins & Salomon, 1988).

Perkins and Salomon’s (1988) framework for thinking about learning transfer (low road and high road) can assist teachers in developing different strategies to help students recognise similarities between two settings or problems. To support students with low road transfer, Perkins and Salomon suggest using a technique they call ‘hugging’ (1988, p. 25). This means that a teacher creates conditions resembling those already known for the new learning context (Perkins & Salomon, 1988, p. 28). Whereas, the authors suggest teachers use a teaching technique they call ‘bridging’ when seeking high road transfer. This kind of transfer involves students being able to see and make connections between the abstract and old and new contexts or problems. To promote this transfer the authors suggest this involves teachers ‘mediating’ between the two settings or problems, for example, by pointing to similarities, to underlying principles, or to relationships (Perkins & Salomon, 1988).

As Perkins and Salomon point out, this is likely to be something that most teachers already do. For example, Haskell’s analysis (2001) identifies different language cues teachers do and can use to invoke explicit awareness of transfer. Larsen-Freeman (2013) also points to this as one of several practices to prompt and cue for enhancing transfer in language learning (her review’s focus). Teaching for transfer in this way requires the extensive use of analogies and metaphors (Haskell, 2001). For example, a teacher might say such things as:

it's like ... it's equivalent to ... for example ... it's akin to ... for instance ... it's the same as ... by the same token ... similarly ... in the same way ... it reminds me of ... it resembles ... or, it's analogous to ... (Haskell, 2001, p. 24).

By framing these sorts of language cues (which teachers might also frame as questions) within the framework of transfer, Perkins and Salomon are linking these sorts of techniques to a deeper pedagogical theory.

3.3 Thinking processes

Mayer’s work (2002) associates transfer with a suite of cognitive processes that require students to not only remember what they have learned, but to make sense of what they have learned and be able to use this learning elsewhere. He argues that transfer involves more than recognition and recall of information. He sees these as

narrower cognitive processes related to remembering. They are important for transfer, but of themselves, insufficient. This has implications for how teachers might plan and teach a lesson or unit of inquiry when a learning intent is to promote the transfer of learning.

To assist, Mayer (2002) offers a transfer of learning taxonomy involving 17 distinct cognitive processes, grouped into five categories. If teachers cultivate these processes in their students, Mayer argues, then this will foster the transfer of learning. Mayer's (2002) five categories are:

- **Understanding** – This involves students building connections between new and prior knowledge and constructing meaning from some form of instructional message (e.g. watching a demonstration). Students do so through using the cognitive processes of (1) *interpreting*, (2) *exemplifying*, (3) *classifying*, (4) *summarising*, (5) *inferring*, (6) *comparing* and (7) *explaining*.
- **Applying** – This involves students using actions to do tasks or problem solve through the cognitive processes of (8) *executing* (i.e. when the task is familiar to the learner) and (9) *implementing* (i.e. when the learner is applying multiple actions to an unfamiliar task).
- **Analysing** – This involves students looking at the distinct parts of 'something' (e.g. key messages) and working out how the parts relate to each other and the overall objective or purpose. Here, students are using such cognitive processes as (10) *differentiating* (e.g. sorting out the relevance or importance of information), (11) *organising* (e.g. working out how elements fit or function together) and (12) *attributing* (e.g. determining an underlying purpose).
- **Evaluating** – This involves students making judgements linked to criteria or standards. These may be quantitative – *Is this a sufficient amount?* – or qualitative – *Is this good enough?* When evaluating, students will use the cognitive processes of (13) *checking* (e.g. their assumptions and testing their conclusions) and (14) *critiquing*. Mayer sees 'critiquing' as at the core of 'critical thinking'.
- **Creating** – This involves students re-organising existing elements or generating new elements to form a new pattern or structure. Creating leads to the making of an original 'product' (e.g. a music composition or a piece of writing). For Mayer, creative processes follow a sequence of (15) *generating* (also referred to as hypothesising 'what if ...' alternatives, which involves divergent thinking); (16) *planning*¹³, known also as *designing methods for accomplishing a task*, which involves convergent thinking; and (17) *producing*, also known as *constructing*, which involves students inventing a stated product (e.g. learning to design their own social enterprise).

The five categories Mayer uses provide a framework for managing the teaching tasks he sees as necessary for nurturing the development of learning transfer. There are clear connections between these processes and the thinking and learning within the VCAA's CCT capability (see also, Appendix 1). With this approach, the ability to transfer equates to meaningful learning (i.e. knowing how to construct meaning).

¹³ Mayer (2002) states that teachers often skip including planning objectives and only state objectives in terms of what students are producing. This makes the cognitive processes of a student's planning invisible and/or assumed.

Doing so, writes Mayer (2002), builds a student's knowledge and cognitive processes for identifying and solving problems.

Other researchers' reviews of the research literature draw similar conclusions about the role that particular thinking and learning processes do and can play. Bransford and Schwartz (1999, p. 64), for example, conclude, "teaching students to think metacognitively – to think about how they think – supports learning transfer". This view is also supported empirically by Gautam and co-authors (2006, p. 833), who show that guided metacognitive feedback is effective in, "preparing students for future learning". (This is especially so when the students are novices learning in a complex setting.) Other research though points to things teachers need to be mindful of in their teacher-student interactions.

Margulieux and Catrambone's (2019) experimental study explored the efficacy of different types of teacher guidance during a problem-solving learning activity. Their study, centred on programming problems, used subgoal (or functional pieces of procedure) learning techniques and self-explanation, defined as students using "prior knowledge and logical reasoning to make sense of new information and gain new knowledge" (Margulieux & Catrambone, 2019, p. 113). Focused on a US technical college context, these researchers randomly assigned 250 participating students (who were classified as novices) into 10 groups across two variables: subgoal learning method (passive, active, guided with hints, guided with no hints, and unconstructed) and response feedback (no feedback or correct response feedback). The average age of the participating students was 19.6 years of age. The authors found that students performed the best under two conditions: when they constructed their own subgoal labels and received hints from teachers, or when they constructed their own subgoal labels and received feedback. However, when participants received *both* hints and feedback, they did not perform as well. There is a balance, Margulieux and Catrambone (2019) conclude, between providing enough guidance to increase learning efficacy and providing too much guidance that hinders knowledge construction.

One aspect Margulieux and Catrambone's (2019) research highlights, is the erroneous assumption that passively teaching thinking processes is enough for enhancing learning transfer. For example, teaching students metacognitive skills to promote their self-regulated learning and then expecting students to spontaneously transfer these learned skills to different domains in school and or life is not sufficient (Margulieux & Catrambone, 2019). The earlier work of Hiebert and colleagues (2003) draws attention to the need for teachers to not only use guided metacognitive feedback, but to use the kinds of feedback that can assist in promoting learning for transfer. An international study across seven countries shows teacher-student interactions will impact on how well students develop and deploy their metacognitive knowledge and skills (Hiebert et al., 2003). This study found it was better for teachers to use seeing and making connection type questions in their guided metacognitive feedback with students (e.g. Why do you think this?) rather than more procedural questions that emphasise execution (e.g. What steps would you take to do that?). Questions that help students to see and make connections help students to 'struggle', which in turn helps them reveal and understand, for example, their reasoning. This sense making and reasoning are viewed as the cornerstones in, for example, mathematics (Hiebert et al., 2003). The research points to several related

pedagogical strategies to enhance students' CCT, in which metacognitive, questioning and reasoning thinking all play a role.

3.4 Teaching principles

There is some empirical evidence to support the importance of teaching the transfer of principles. We define a principle as an idea or belief that guides the behaviour and expectations of individuals and organisations. Bereiter (1995) concludes that teachers should concentrate on teaching the transfer of principles because this helps students to transcend uncritical beliefs and superficial explanations.

In assessing the effects of explicitly teaching for transfer, Fuchs and colleagues (2003) conducted experiments with grade three mathematics teachers and students in the US under four conditions: teacher-designed instruction as per the district's curriculum (the control) plus variations of three experimental approaches using explicit solution instruction, worked examples and peer-mediated practice. Analysing the results, they concluded that a combined treatment of explicitly teaching students the concept of transfer plus solution instruction was the most effective for both near and far transfer. This work highlighted the "potential for promoting metacognition in mathematics for school-aged children" (p. 295) and the value of *explicitly* teaching for transfer.

Rosholm and co-authors (2017) conducted a study of 482 primary school students who were attending chess lessons. The students were divided into two groups. One group were taught explicitly how to solve chess problems. While this was being done, the other group continued with their regular mathematics lesson.

The 'treatment' group out-performed the other group in mathematics performance, leading the researchers to conclude that chess skills transfer and improve children's mathematical skills. The effect size (0.16 – 0.18) was, however, quite small (when controlling for a wide range of background variables) (Rosholm et al., 2017, p.11). This was a partial replication of an earlier study by Sala and Gobet.¹⁴ This other study found a stronger effect size of 0.38. Rosholm and co-authors attributed the effect of chess skill transfer to mathematics performance to a skill transfer but also noted that affective elements (happiness, lack of boredom) could not be discounted.

In a medical education experimental study (Kulasegaram et al., 2017), 90 novices were randomly selected to learn basic physiology concepts, with or without an emphasis on underlying science concepts. This small (but sound) study found that emphasising basic science principles assisted transfer.

Halpern and Hakel (2003) offered ten (empirically validated) principles for understanding learning transfer. Their focus was the higher education context, but they began by connecting this context to a learner's typical former context, school. They wrote:

If we want transfer, we need to teach in ways that actually enhance the probabilities of transfer ... We need to remember that we are teaching toward some time in the future when we will not be present – and preparing students for unpredictable real world 'tests' that we will not be giving ... (Halpern & Hakel, 2003, p. 38).

¹⁴ The authors cite Sala and Gobet (2016), but this appears to be an error. The paper cited appears to be a review article. The original research appears in Trincherro and Sala (2016).

Halpern and Hakel's (2003, pp. 38-41) principles for effective learning transfer are:

1. **Practice retrieval** – Generate responses across time in a variety of contexts, with minimal cues. The more this is done, the more a learner accurately and fluently retrieves information.
2. **Vary learning conditions** – The greater the variation in learning conditions, the better the learning. In practice, this involves offering learners different types of problems and solutions within the one lesson.
3. **Use multiple formats** – Take information that is presented in one format and 're-represent' it in another. In practice this means enhancing a learner's learning and recall by using visual and auditory processing activities (or 'dual coding').
4. **Take account of prior learning** – This involves discovering the prior knowledge, beliefs and understanding of learners at the start of every instructional encounter.
5. **Take account of how students (and teachers) understand what constitutes knowledge** – As Halpern and Hakel state: "Learning is influenced by both our students' and our own epistemologies" (p. 39).
6. **Provide systematic feedback** – Without feedback current beliefs about how 'something' works might get strengthened, even if they are 'wrong'.
7. **Match assessment to the learning** – The type of assessment needs to match the learning intent. For example, if the learning intent is to measure understanding, then teachers might use cues to help trigger interpretative thinking and provoke learner engagement with, for example, a scenario, a question, a problem and so on.
8. **Recognise that transfer of learning does not happen in isolation** – Transfer has a number of interdependences (e.g. contexts, time). This has an implication when teaching for transfer because what teachers spotlight is what learners will attempt to recall. This can lead to 'selective forgetting' of the information learners were not asked to recall. Similarly, frequent testing soon after the learning of information may lead to learner 'over confidence'. This may result in short-term retrieval benefits, but may also result in learners investing less time and effort for future recall.
9. **Find a balance between how much and how well something is learnt** – Teachers need to consider the amount of detail that learners will need (sometime in the future, in some unknown time or place) when the teacher is not present. This may lead to focusing on in-depth understanding of basic principles.
10. **Ensure that students are active learners** – Halpern and Hakel state: "What learners do determines what and how much is learned, how well it will be remembered, and the conditions under which it will be recalled"(p. 41). In practice, this shifts the focus from what teachers do in their classes, to what (and how) students think and do.

3.5 Analogical thinking

The use of analogies is an explicit strategy to elicit students' thinking about the underlying principles of 'something'. Different studies refer to the use of analogies or employ the use of analogies within their design (Minervino et al., 2017; Margulieux & Catrambone, 2019; Richland et al., 2012; Terwel et al., 2009).

An analogy¹⁵ invites a student to compare two 'things' (e.g. objects or systems of objects or contexts). This is a simple approach that teachers do and can use to incorporate language cues, as noted already (e.g. "How is X a bit or a lot like Y?"). A more complex, but linked topic, is the use of metaphors. A metaphor is also a form of analogising in that it seeks to invite a person to make a comparison. A metaphor tends to compare two very obviously different things or subjects (e.g. Shakespeare's Romeo likens Juliet to the sun). Reasoning, as in the VCAA's CCT sub-strand, best links to this type of thinking, with teachers or students making use of an analogy to make comparisons and express this thinking in the form of assertions or arguments. In turn, this can assist students to develop, practice, demonstrate and deploy their problem solving, as they seek to explain their thinking.

Richland and colleagues (2012, p. 193) see analogical reasoning as "closely related to transfer" and define it as:

The process of identifying goal-relevant similarities between what is typically a familiar *source* analog and a novel, less understood *target*, and then using the set of correspondences, or *mapping*, between the two analogs to generate plausible inferences about the latter.

Their reviews of psychological and educational research sought to examine the K-12 pedagogical practices for enhancing the long-term ability of students to transfer and engage with mathematics. They concluded that many schools are "failing to teach their students the conceptual basis for understanding mathematics that could support flexible transfer and generalization" (Richland et al., 2012, p.189). Instead, they argue, students should be encouraged to approach mathematics using their broad sense-making repertoire by drawing connections with existing knowledge. Importantly, they add, these connections must be made by the student, not by the teacher *for* the student and this will require student effort. Leveraging students' reasoning skills, they conclude, "may be a crucial way to enhance their ability to develop usable, flexible mathematics knowledge that can transfer to out-of-school environments" (p.201).

To foster this approach, Richland et al. (2012) highlight the importance of understanding not only analogical reasoning in education, but also the pedagogical strategies that can support it. They emphasise in particular the need for more professional development to help teachers in analogical thinking, to learn how to represent problems as "goal-oriented systems that can be connected meaningfully to other problems, representations and concepts" (p. 201).

3.6 Examples

Related to the teaching of underlying principles and associated analogical thinking strategies, there is one point on which nearly all the researchers agree: the use of examples promotes learning transfer. As Haskell notes:

¹⁵ See Stanford Encyclopedia of Philosophy <https://plato.stanford.edu/entries/reasoning-analogy/> .

Study after study clearly shows that students who are provided the opportunities to study examples of a problem do better than students who are merely given the opportunities to work out a given problem. (Haskell, 2001, p. 15)

In conducting two experiments with university undergraduate students in the US, Minervino et al. (2017) agreed that comparing a target problem to an analogous problem or example helped student retrieval from memory, even when examples lacked some 'surface similarities' (e.g. a doctor attacking a tumour, and a general attacking a fortress). However, they argued that retrieval from memory or transfer could be improved further if a *second* analogous example of the problem they were trying to solve was generated (e.g. a doctor attacking a tumour, a general attacking a fortress and a fire chief attacking a fire). Furthermore, the actual *construction* of an analogous problem by students was even more effective. Importantly, comparing *non-analogous* examples (e.g. a doctor attacking a tumour and scientists weighing an asteroid) did *not* bring the same advantages as this did not "elicit an appropriate abstract representation" of the problem to be solved (p. 226). Minervino et al.'s (2017) experiments built on existing studies that highlighted the importance of retrieving examples to solve problems, emphasising the role that "interdomain analogizing serves as a basis for many other activities such as augmentation, explanation, creative design, or instruction" (p. 230).

Bransford and Schwartz (1999, p.64) suggest that it has now been established that:

Presenting concepts in multiple contexts assists transfer because it breaks the nexus between the concept and a particular context. A teacher might, for example, facilitate this by asking students, for example, 'what if' questions.

Haskell's (2001) review points out that the underpinning understanding of transfer between contexts hinges upon judgements of similarity. What is a 'near' transfer for an expert is, for example, a 'far' transfer for a novice. The level of abstraction that students make for the transfer of learning must be appropriate.

So, while we might understand the notion of transfer and provide strategies and examples to promote it, how can we be sure that these are appropriate and will enhance learning effectively? Teaching for learning transfer remains a complex undertaking for teachers and students.

4. Challenges in enhancing learning transfer

How to transfer learning and how well this occurs is an enduring issue (Barnett & Ceci, 2002; Collins, 2018; Haskell, 2001; Macaulay & Cree, 1999; Perkins & Salomon, 1992; Schwartz et al., 2005). Marini and Genereux state this is one of teaching's most formidable problems. They write:

... researchers have been more successful in showing how people fail to transfer learning than they have been in producing it, and teachers and employers alike bemoan students' inability to use what they have learned. (Marini & Genereux, 1995, p. vii)

Part of the reason why the transfer of learning is a challenge, is the assumption that transfer will 'take care of itself' (Haskell, 2001; Marini & Genereux, 1995; Perkins & Salomon, 1992). As long as the learner acquires some knowledge and skills in one area, then it is assumed that this will carry over to another context (Perkins &

Salmon, 1992). But there are other common challenges to the researching and teaching of learning transfer, as discussed below.

4.1 Measuring learning transfer

Measuring transfer is seen to be important for evaluating the effectiveness of education (Barnett & Ceci, 2002, p. 62), although some authors (e.g. Salomon & Perkins, 1989, p. 138) argue that the measurement of transfer is impossible. The failure to find evidence of transfer, argue Bransford and Schwartz (1999), occurs because transfer is conceived of as the direct application of a set of skills. To measure these skills, typically in experimental settings, subjects have the context (in which they are to demonstrate transfer) “sequestered” (Bransford & Schwartz, 1999, p. 68). That is, the environment is cleansed of the complicated settings of the real world. It is better, they argue, to look for transfer in settings that reflect real world complexities, where the imperative is not to transfer specific skills, but rather to have an orientation towards future learning (Bransford & Schwartz, 1999, p. 68).

Schwartz and co-authors (2005) argue that part of the challenge is to ensure that when monitoring transfer, assessments are made of what learners transfer in and what they transfer out of situations. By framing transfer in this way, these researchers argue, instructional techniques are made visible. This led them to include the dimensions of ‘efficiency’ and ‘innovation’ in their theory of learning transfer.

Barnett and Ceci (2002) note the need to address the lack of progress in understanding how to cultivate the more challenging ‘far transfer’ (rather than ‘near transfer’). They argue there is a need to specify the various dimensions along which transfer *can* occur. For them, the concept of ‘far transfer’ presents the greatest challenge. To assist in addressing this challenge, they see research into transfer as a multi-disciplinary endeavour and identify four types of research in their review of the evidence:

1. Studies of analogical transfer (training in one task followed by testing on a novel task).
2. Tests of the formal discipline hypothesis.¹⁶
3. Attempts to teach high order skills (e.g. critical thinking, including metacognition).
4. Evaluations of the effects of schooling.

Barnett and Ceci’s (2002) review identifies some instances of far transfer (e.g. students transferring their learning from a science class intervention that focused on students’ metacognition and higher order thinking skills to assist them in completing their English exams two years later).¹⁷ They conclude that far transfer is

¹⁶ This research tradition goes back to the early twentieth century with the pioneering work of Thorndike and Woodworth (1901) who used experiments to investigate the claim that practice had general effects. That is, if students practised learning it would lead to a general increase in ‘general skills of learning and attention’. This could be done, for example, by learning Latin (Barnett & Ceci, 2002, p. 62). What Thorndike and Woodworth found was that this long held view – dating back to ancient Greece – did not hold true. Students were good at learning the specifics of the tasks, but did not generalise this to new settings (or, to use current terminology, did not transfer their learning).

¹⁷ Barnett and Ceci (2002) cite this notable study from Adey and Shayer, (1993). They also reference Herrnstein and colleague’s 1986 comprehensive evaluation of a Venezuelan seventh grade’s thinking skills program, finding program benefits transferring to a creative design task and practical reasoning question about personal health. The researchers also make specific note in their review of Sternberg’s 1995 triarchic theory – teaching students how to think from an analytical, creative, or practical perspective.

documentable and might even be predictable, if the relevant dimensions of far transfer are specified. To assist in this, Barnett and Ceci (2002) produced a 'far transfer framework' (taxonomy) of nine dimensions against which they suggest the transfer of a learned skill might be assessed. These are grouped into two categories: 'what' is transferred and the 'context' of the transfer (See Appendix 3 for the categories).

Distinct, but related to measuring learning transfer, are the following challenges:

- **4.1.1 Teacher mindset:** In their research, Gordon and Doyle (2015) observed that, if teachers implementing a program had little or no commitment to transfer of learning, then they treated this learning intent from the program as 'unimportant' or as an 'extra' outcome. Often these teachers were more interested in short-term improvements, for example, in focusing on classroom behaviour as a way to also improve students' wider personal and social responsibility.
- **4.1.2 Learning of novices and experts:** A large body of literature (over the years) identifies that a key challenge for teaching for learning transfer (and one of its shortcomings) is the misunderstanding of theories of transfer themselves. Bransford and Schwartz (1999) note that negative claims arise not because transfer does not occur, but because it is misconceived, and researchers are using the wrong tools and looking at transfer in the wrong way. At the nub of this argument, from researchers who share this claim, is that theories of transfer explain the learning of experts, but not of novices (Blume et al., 2010; Detterman & Sternberg, 1993 in Bransford & Schwartz, 1999; Macaulay & Cree, 1999).
- **4.1.3 Exposing learners to multiple opportunities:** Importantly, this requires more time for fully expressing this orientation towards future learning (in research studies this is longer than is typically given to subjects in an experiment and what the daily timetabling of schools may easily accommodate). Bransford and Schwartz (1999, p. 69) suggest, for example, that "transfer is much more pronounced on the second day of learning transfer". This longer time requirement reflects this richer notion of learning transfer. It also provides an opportunity for the use of tacit knowledge. This is knowledge that is often unavailable to recall, but which shapes thinking (Bransford & Schwartz, 1999, p. 70).

Bransford and Schwartz (1999) argue for approaches that reflect how people actually transfer, using cues and their specific frame of reference (or schema) for interpreting a situation or problem. This places the focus on, as the authors write, "extended learning", rather than on "one-shot task performances" and reveals benefits that are otherwise hard to measure, but educationally important (Bransford & Schwartz, 1999, p. 78). Despite these benefits, this richer approach takes longer and imposes potential inefficiencies, especially where the skill transfer, say, is relatively straightforward. This suggests there may need to be some balancing between efficiency and this richer approach (Bransford & Schwartz, 1999, p. 78).

- **4.1.4 Learner capabilities:** There is the need to take into account (1) a learner's ability to recognise a transfer opportunity and its relevance from prior learning or performance, (2) be motivated to transfer, and (3) have the

resources to do so when a transfer of learning opportunity presents itself (Marini & Genereux, 1995).

Further, the evidence suggests we cannot assume that once the principles and techniques of transfer are taught and learned by students that they will recognise or deliberately apply them for wider purpose and benefit. This appears to be the case especially for what Perkins and Salomon (1992) call far transfer (outlined earlier). They argue that, “conventional educational practices often fail to establish the conditions either for reflexive or mindful transfer” (Perkins & Salomon, 1992, p. 2). Bereiter (1995) argues that no matter how well a dispositional principle is understood, whether a learner will apply that principle, especially in situations of crisis, is debatable. He also notes from the research that it is less typical for learning transfer to occur when problems are even slightly different.

- **4.1.5 Pre-service education:** Looking at the challenges of transfer from a different perspective, Haskell (2001) suggests that the reason transfer of learning seldom occurs in schools is the neglect of the topic in pre-service education. Halpern and Hakel (2003) agree. From their observations in higher education, the preparation of college teachers consists of in-depth academic disciplinary study, but, as they say, “Very little, if any, of our formal training addresses topics like adult learning, memory, or transfer of learning” (Halpern & Hakel, 2003, p. 37). They could find little evidence, for example, of teachers in higher education applying the principles in the classes they teach. Instead, they note, they teach “like virtually all college faculty, they teach the way they were taught” (Halpern & Hakel, 2003, p. 37).

5. CONCLUDING OBSERVATIONS

5.1 Researchers agree: Learning transfer is important

Most writers see the transfer of learning as important in and beyond schooling. Some go further to assert it is *the* ultimate aim of teaching because it is foundational to learning, thinking and problem-solving. A number note the inextricable link between learning and the transfer for learning. For these researchers, learning and transfer co-exist, with learning the fundamental precondition for transfer.

Across the literature, writers identify a range of immediate and longer-term benefits for learners from the transfer of learning. They report these benefits as cultivating and improving learners’:

- Critical thinking, including looking beyond an ‘obvious’ answer and problem-solving. (As highlighted in the introduction, this is particularly significant for the VCAA.)
- Ability to notice and take account of various viewpoints.
- Increased confidence.
- Life-long habits to plan, deal with and adapt in a changing world.

- Increased agency and improved decision-making, which, in turn, some note leads to increases in expressions of learner curiosity and community engagement.

Some writers also link such benefits to improving future employability and citizenship outcomes.

Having established learning transfer as important, it is also clear from the literature that how researchers frame learning transfer affects its meaning, usefulness and very existence as an observable phenomenon. Researchers think about learning transfer in a wide range of ways. In part, this is unsurprising given it has been a topic of research and commentary for more than a century.

As noted, simply put, learning transfer is the ability to recognise what has been learned in one context and apply and extend that learning to another context. From here, the language across the literature reflects different dimensions and areas of emphasis. These seem to spawn different mental models of learning transfer. Notable dimensions researchers refer to in one or more contexts, as discussed throughout this paper, include Haskell's (2001) 11 dimensions (and six levels of transfer) (see appendix 2); Barnett and Ceci's (2002) nine dimensions, divided into 'what' and 'context' categories (see Appendix 3); and Schwartz et al.'s (2005) theory of learning transfer, which includes the dimensions of 'efficiency' and 'innovation'.

As researchers explore these dimensions through their various lines of inquiry, more nuanced positions on learning transfer appear.

Some writers see learning transfer as a higher thinking skill, which can be taught and learned. Others argue learning transfer refers to a learner's disposition or mindset (i.e. a habit of mind that predisposes people to want to learn and keep learning, rather than an instructional technique). While others assert the whole transfer metaphor is wrong because it implies a series of discrete acquisition events, rather than a view of transfer as an ongoing process. Those in this camp view the human subject making the transfer as pivotal. Knowledge is not 'a thing' that is simply 'carried about' by the individual. Instead, these researchers argue, learning transfer is better viewed as a transition, an adaptive process, in which an individual plays an active role, applying and reshaping learning. This view of learning transfer emphasises what learners bring to a situation, not simply what they possibly transfer out.

A frequent framing, citing or elaboration of learning transfer in the literature comes from the thinking and research of Salomon and Perkins (1988, 1992). Their framing of learning transfer places the emphasis on the how and, in their later research, they extended this thinking to encompass dimensions of forward-reaching (anticipatory) and backward-reaching (relevant retrieval) transfer of learning. We summarise each of these in Table 1, presented earlier in the paper.

Regardless of the lens on learning transfer, many of the participants in these debates draw attention to the dynamic interaction between three factors, all of which are relevant to learner, setting and context:

- What is transferred;
- How transfer occurs; and
- The context of the transfer.

5.2 Opportunities for cultivating learning transfer

A point on which nearly all the researchers agree is:

- **The use of examples with learners promotes transfer.** That is, learners who are given opportunities to study examples (in multiple contexts), do better than those who are simply given the opportunity to work out a problem. Some authors specifically suggest using exploratory approaches (e.g. discovery learning, hands-on learning and experiential learning), as well as the use of facilitative open-ended type questioning, such as ‘What if ...?’. Others note that opportunities need to be authentic and seen by learners as relevant and, so, of value.

The literature also points to a range of other individual teacher habits, processes or combinations of these (e.g. use of language cues) through to more sophisticated teaching for transfer thinking and strategies (e.g. use of principles). In summary, these suggest there is a need for teachers to:

- **Recognise and value the need to teach for transfer** - A teacher’s disposition to the transfer of learning and his or her role in this can enable transfer through developing a learner’s positive orientation towards future learning.
- **Pay attention to what learners are bringing to a situation as they begin their learning** – Recognising strengths, knowledge, strategies, processing skills and prior learning (and the quality of existing prior knowledge), is said to be a key precursor for transfer.
- **In a program, discuss the idea of transference with learners early and upfront** - This strategy was noted in a program with secondary school students.
- **Invoke explicit awareness of transfer through the use of analogies and metaphors** - Prompted through, for example, language cues, such as, ‘it’s like ...’, ‘it reminds me of ...’, ‘it resembles...’.
- **Provide explicit opportunities for learners to use their learning in their lives.**
- **Ascertain whether learners are able to recognise a transfer opportunity and its relevance from prior learning or performance.**
- **Cultivate cognitive processes, which also seem to encourage learners to self-assess** - Specifically:
 - **Assist learners** to recognise similarities between two settings or problems through, for example, the technique of hugging for low road transfer – hugging involves teachers creating conditions resembling those already known for the new learning context. And, use a bridging technique for high road transfer situations. Bridging involves a teacher acting as a ‘mediator’ by pointing to similarities to underlying principles or to relationships. When bridging, some writers suggest teachers give learners ‘expert explanations’ as a point of comparison after learners have come up with their own ideas first.

- **Foster learners'** 'understanding'; 'applying'; 'analysing'; 'evaluating' and 'creating' suite of cognitive processes, inclusive of metacognition (see Mayer's list on page 11).
- **Concentrate on developing and teaching the transfer of principles** - Many of the principles are inclusive of the list above – albeit through the use of different language or emphasis (see the examples listed on page 14). A rationale for this approach is that teachers are teaching toward some time in the future, where learners are likely to face unpredictable real-world tests, and without their teachers present.

5.3 Challenges for cultivating learning transfer remain

We can frame many of the challenges for cultivating transfer as arising from *not* doing what the list above suggests enables transfer.

A number of researchers point to far transfer as presenting the greatest challenge, because it requires high order thinking. Others suggest that making judgements between what constitutes similarity and dissimilarity of context and between two performances is not straightforward and therefore remains a challenge.

Some researchers argue that the reporting of 'lack of transfer' is because transfer is being misconceived, investigated using the wrong tools and looked at in the wrong way. The nub of these types of arguments is that theories of transfer explain the learning of experts, but not of novices.

Others suggest that the reason transfer of learning seldom occurs in schools is the neglect of this topic in pre-service education,¹⁸ with teachers teaching 'the way they were taught'.

These debates and the limitations in the research make drawing firm conclusions difficult. However, it seems clear to us that learners need to be motivated and make an effort to learn, be interested in the learning, see it of value, and be able to recognise and extend their learning. This involves teacher commitment to the value of transfer and developing shared mental models of learning how to learn, particularly as it expresses itself in different contexts (near and, especially, far). And finally, it seems very likely to us, that teachers should avoid the assumption that transfer will take care of itself.

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¹⁸ Whether this claim still holds true today in pre-service education would require further investigation.

APPLYING THE LEARNING

During 2019¹⁹, the literature review informed the thinking for activities and support tools with teachers to explore with them, such questions as; ‘How might we cultivate learning transfer in our schools to pre-empt leaving transfer to chance? And, how can the CCT capability enable learning transfer?’

Schools who are serious about cultivating and building teaching and assessment practices for learning transfer enact three key principles (Table 2).

With each principle we offered, from the research, some strategies for bringing these principles ‘to life’. Together, they can support embedding intentional practices for learning transfer – even if, as teachers we might not ‘see’ the outcomes of our teaching in our classes or in our time with students at school.

Principles for promoting learning transfer	Strategies for embedding learning transfer include:
<p>Practicing: We expose learners to multiple contexts, examples and experiences, which requires seeing and making connections</p>	<ul style="list-style-type: none"> • Provide opportunities for consecutive iteration (including deliberate practice), each time vary the activity slightly (e.g. change the context, reduce language prompts or cues). • Create iterative opportunities for learners to shift between ‘learning about’ something <i>and</i> ‘learning to’ do something. • Use ‘authentic’ exploratory approaches (e.g. discovery learning, hands-on learning and experiential learning). • Students annotating their work to recognise, generate their own explanations to understand their progression of learning. (e.g. e.g. Inversion thinking) • Use analogies and metaphors as prompts and cues (e.g. for learners to see similarities and, importantly for transfer, differences: “How is ... like and not like a ...? How might this skill of being able to identify similarities and differences help you in another learning area?” Or teachers might give and show examples, “it’s like ... it’s equivalent to” ... for example ... it resembles ...” • Use of worked examples as prompts and cues • Developing and teaching of principles (‘mental models’ e.g. Socratic Questioning; 5 Whys).
<p>Mindset: We embrace the expectation for learning to transfer.</p>	<ul style="list-style-type: none"> • Discuss early and upfront in the unit of inquiry or a program the idea of transferring learning. • Incorporate questions for prompting and cuing transfer when planning lessons.
<p>Agency: We prioritise students playing an active role in their learning</p>	<ul style="list-style-type: none"> • Students create ‘success’ criteria and consider other uses (e.g. “What makes a quiz good? How might knowing what makes a quiz good also be useful when I am learning new vocabulary in another learning area?”). • Generate a drop-down menu of student transfer prompts: “Where have I seen this before?” “What does this remind me of?” (both of these questions are useful for identifying and recognising prior learning) “Where else could I use this?” “How else could I use this? (useful for developing a mindset bias for transfer and encouraging students to recognise a transfer opportunity and its relevance, as well as imagine and anticipate uses for their learning).

Table 2: Principles and strategies for effective teaching for transfer

¹⁹ Bill Lucas and Michelle Anderson, with Sharon Foster led and contributed to two sessions with teachers in Victoria (March) and New South Wales (October).

Teachers generated prompts for thinking about learning transfer through the mechanisms of time and context. Teachers at the March workshop also generated prompts for the key principles of practising and agency. In addition, Bill and Michelle invited teachers to identify areas they still wanted to know more about.

On the next three pages, we provide a curated list of these teacher suggested examples and areas for future professional learning.

Student ‘play list’ of learning transfer prompts

Examples have been organised under the most relevant of the three mechanisms.

Time:

- What did I learn then?
- Where have I seen this before?
- Have I heard about...?
- I think I’ve seen something like this when...
- Does it remind me of something?
- Where have I learnt a similar skill?
- What do I already know that could help me with this task?
- What does this remind me of?
- How can I remember this for tomorrow or in the future?
- How could you use this knowledge again after today?
- How might I use this knowledge next year?

Context:

- How might things (or ‘X’) be different in ...?
- What does that seem similar to ...?
- What did I learn there?
- Where do I do something like this out of school?
- Where would I use....when planning a? (Familiar)
- Where would I usewhen planning a? (Unfamiliar)
- How can I apply this skill or knowledge to other classes?
- How would this look/feel if I was in another class?
- Draw where else I would see this.
- How might I use this in the ‘real world’?
- Who else could use this? Who else *should* use this?
- What’s a different way I could communicate that message in ...?
- In which other situation(s) would ‘this’ be appropriate to do?
- When I did ‘x’, in ‘this context’, I used ‘this’ strategy. Which context might I use this strategy again? Which context might mean I need to use a different strategy?
- How could I demonstrate this ‘knowing, doing, being’ in another area of my life?
- Can I give five examples of when I might use ...in ...?
- How might I show that have learned this learning intention by applying it in ...?
- How can I use that skills/knowledge in my kitchen, sport’s team?
- How can I use this to help me in x?

Principles for learning transfer

Principle: Practising (We expose learners to multiple contexts, examples and experiences, which requires seeing and making connections.)

Strategies: Developing and teaching principles ('mental models').

Below are some student prompts for the principle, practising:

- Disagree with one idea today and explain why.
- How will I know if I have been successful?
- What does success look like in this example?
- How can I improve my product to ensure it's successful next time?
- How well do I understand the concept?
- What does this question assume?
- Where do I sit, about this task/idea/lesson/concept? Scale of 1-5
- What's weird or unusual about this?
- What part/s is confusing me?
- What do you think of when I say...?
- What do you already know about...?
- Why do you need to know this?
- Why does this interest me?

Principle: Agency (We prioritise students playing an active role in their learning)

Strategies: Incorporate questions for prompting and cuing transfer when planning lessons.

A play list of questions students might ask themselves or ask each other:

- How could I make that harder for myself?
- How could I make this activity more difficult?
- Can I tell someone else more about that?
- Who am I going to teach that to?
- How could I create a learning task or assessment for 'this'?
- What would I include if I was creating a rubric for success criteria?
- Can I change any part of this to...?
- How would I try this with ... in ... if I was ...?
- How could I challenge myself further?
- If I can re-do this, what would I change?
- Can I come up with some questions for today's context?
- How else can I apply this feedback?

Future areas of focus for teacher professional learning

Teachers expressed interest in learning more about and how to do these aspects of teaching for learning transfer:

Embedding 'it':

- How do you ensure it happens when the curriculum is so full?
- How do you maximise the effect of learning transfer?
- How can the capabilities explicitly be taught for student understanding?
- How does school curriculum best encourage context beyond stipulated tasks?
- What 'meta-cognition' understanding and skills can I use for my learning area?
- What tips can I apply to ensure students develop their meta-cognition knowledge and skills?
- What 'questions and possibilities' understanding and skills can I use for my learning area?
- What 'reasoning' understanding and skills can I use for my learning area?
- How do you integrate it into the regular day-to-day teaching practice?
- How can I best facilitate the transfer of learning?
- How can I help students apply their thinking across a range of knowledge areas?
- What is the best way for me to scaffold to enhance learning transfer?
- How detrimental is the statement to students "you should have already learned this" to their transfer of learning?
- How best can teachers assist students to recognise the capabilities and apply them within the subject areas?
- How do I differentiate learning transfer strategies to suit different learners?
- How do I teach learning transfer in a way that is clear to all students?
- What are effective strategies to ensure transfer when differentiating for various student entry levels?
- What's the best way to achieve deeper understanding of learning transfer in the junior school?
- How do I ensure students' learning is remembered and that they are able to apply their learning in the next task or next year etc?
- Might I be overusing learning transfer?

Assessing and measuring 'it':

- How do I know that students have gained the skill for the long term?
- How do I know they've got it?
- How do I challenge teachers who use test results (only) as evidence of learning transfer?
- How do I effectively assess that teaching for transfer practices have been successful? (i.e. and students not just simply repeating back what they have heard.)
- How can we measure learning transfer?
- How similar is learning transfer to adaptive skills learning?

The authors would like to acknowledge the contributions of more than 150 teachers to this applying the learning section.

APPENDIX 1: CRITICAL AND CREATIVE THINKING CAPABILITY STRANDS

The VCAA's critical and creative thinking capability combines two types of thinking – critical (e.g. interpreting, analysing, evaluating, explaining, comparing, questioning) and creative (e.g. generating and applying new ideas, seeing and making connections, identifying alternative explanations).

The VCAA defines these types of thinking as strongly linked, but not interchangeable. This stance by VCAA, views CCT as bringing complementary dimensions to thinking and learning, which VCAA organise in the Victorian Curriculum F-10 through this capability's three strands – Questions and Possibilities, Reasoning and Meta-Cognition.

The VCAA website²⁰ describes the learning in CCT as follows:

The Questions and Possibilities strand is the basis for all effective learning and provides a structure for inquiry-based approaches to teaching. Helping students understand the fundamental role that questions and questioning play in enabling learning and developing a learning disposition is a necessary condition for deep learning. The Questions and Possibilities strand supports students to develop their imaginative and intuitive capacity as well as fostering a curious and speculative disposition. Students apply these to propose novel ideas, develop original artefacts and make new connections.

The Reasoning strand provides students with the knowledge and tools to both construct and evaluate ideas and arguments that may be unfamiliar. It underpins other areas of the curriculum in which students are required to gather, consider and evaluate data, evidence and propositions and then form conclusions.

The Meta-Cognition strand defines the knowledge and skills that enable students to better identify, describe, understand, practice, develop and manage their own learning processes. Critical and creative thinking processes are not discrete but are related within each of the strands. For example, part of creative thinking is establishing and using criteria to critically evaluate the merits of various propositions generated by creative thinking processes. Likewise, critical thinking can involve the application of creative thinking processes to generate novel criteria that can then be used to evaluate propositions in innovative and productive ways.

As the preamble on the VCAA website reiterates and reinforces, collectively these CCT thinking processes are “fundamental to effective learning across the curriculum”.

²⁰ The VCAA website's description of the learning in CCT: <https://victoriancurriculum.vcaa.vic.edu.au/critical-and-creative-thinking/introduction/learning-in-critical-and-creative-thinking>

APPENDIX 2: ENHANCING LEARNING TRANSFER

Example: Six Levels of transfer taxonomy

Haskell (2001, p. 29) proposes six levels of transfer, which together form a taxonomy:

- **‘Non-specific transfer’** - The first and lowest level. This is ‘every day’ learning that draws upon the past, but in terms of pedagogy, is of little consequence. Haskell calls it ‘somewhat trivial’. This is not to claim that it is unimportant, it is just that it is not especially important in a classroom. Non-specific transfer is something people do all the time.
- **‘Application transfer’** – The second level. This occurs when learning for a specific task is applied to that task. Haskell cites the example of learning to use a word processor and then actually using it. He says that while this may seem an ‘outrageously condescending example’, application transfer is a very common learning problem.
- **‘Context transfer’** - The third level. This involves applying what has been learned in a slightly different context. This change in context can remove cues that were used in the original learning and interrupt the transfer.
- **‘Near transfer’** - The fourth level. This occurs when a learner uses previous knowledge to transfer it to a similar, but not identical situation. The example Haskell uses is calculating the area of flooring to be tiled based upon classroom-based exercises in calculating the area of a rectangle.
- **‘Far transfer’** - The fifth level. Far transfer happens when a learner applies learning to situations that are quite different from the original learning situation. For Haskell, this is equivalent to analogical thinking.
- **‘Displacement or creative transfer’** - The sixth and highest level. Here the connections made are new, producing a new concept and understanding. (Haskell, 2001, p. 29)

While this approach probably has heuristic value, Haskell is quick to point out that the underpinning understanding of these various levels hinge upon judgements of similarity. What is a ‘near’ transfer for an expert is, for example, a ‘far’ transfer for a novice. This makes the use of the taxonomy difficult in research settings, but it does help teachers.

For Haskell, Levels 1 and 2 reflect everyday learning, and not what he considers transfer. Level 3 is ‘simply the application of learning’ (Haskell, 2001, p. 30) and so also not transfer of relevance to teachers. It is with Levels 4, 5 and 6 that the term best applies. These lead to *new* learning (Haskell, 2001, p. 30), and that is the prime focus of teachers. This taxonomy also lends itself to arguments about schooling being for ‘education’ rather than ‘training’.

Following a review of the research across multiple fields, Haskell proposes 11 key dimensions that underpin the effective transfer of learning that teachers ought to attend to. These are:

1. Acquiring a large primary knowledge base in the area in which transfer is required.

2. Acquiring some level of knowledge base in subjects outside the primary area.
3. Understanding what transfer of learning is and how it works.
4. Understanding the history in the area(s) that transfer is wanted.
5. Acquiring motivation, or more specifically, a 'spirit of transfer'.
6. Developing an orientation to think and encode learning in transfer terms.
7. Creating cultures of transfer or support systems.
8. Understanding the theory underlying the area(s) to which transfer is needed.
9. Engaging in hours of practice and drill.
10. Allowing time for the learning to incubate.
11. Observing and reading the works of people who are exemplars and masters of transfer thinking. (p. xv)

APPENDIX 3: A TAXONOMY FOR 'FAR TRANSFER'

Barnett and Ceci's (2002) created a taxonomy for how to cultivate and assess the concept of 'far transfer'. They suggest the transfer of a learned skill might be assessed against their taxonomy's nine dimensions, segregated into three 'what' categories and six 'context' categories.

The three 'what' categories are:

1. Learned skill.
2. Performance change, which involves changes in speed, accuracy and approach.
3. Memory demands from low (the skill just needs to be executed) to moderate (recognition and execution) to high (recall, recognition and execution).

The remaining six dimensions are 'context' categories (when and where the transfer occurs, from and to). These categories range from near to far, where far requires high order conceptual thinking and near is specific and concrete:

4. Knowledge domain, which varies from very limited differences, for example from a mouse to a rat (near) to say, a high-level difference between the sciences and the arts (far).
5. Physical context, the transfer occurs in the same location (near) to far away, say, school room and beach.
6. Temporal context, the transfer occurs soon after (near), days, weeks, months or years later (far).
7. Functional context, the transfer relates to very similar goals, for example academic, or distant ones such as academic versus play.
8. Social context, transfer is from individual to individual (near) through to individual to society (far).
9. Modality, the transfer uses the same medium, for example both are written (near), compared with disparate, such as a lecture and a sculpture (far).
(Barnett & Ceci, 2002, p. 621, based on their Figure 1)

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