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Chapter 7

A model of learning

Optimizing the effectiveness of learning strategies

John A. T. Hattie and Gregory M. Donoghue

Since the publication of his well-known books Visible Learning: A Synthesis of over 800 Meta-analyses Relating to Achievement *(2008) and* Visible Learning for Teachers: Maximizing Impact on Learning *(2011), John Hattie has held a central position in current learning and educational research and theory. Since 2011 he has been a Professor of Education and Director of the Melbourne Education Research Institute at the University of Melbourne in Australia. Gregory Donoghue is a researcher and lecturer at the same institute. The following chapter is a shorter version of their joint article 'Learning strategies: A synthesis and conceptual model' in* Nature: Science and Learning *(No. 1, 2016).*

Introduction

There is a current focus on the development and measurement of twenty-first century skills. This search has been conducted for millennia – at least since Socrates, Plato, and Aristotle. We still use Socratic questioning, probing questions, seeking evidence, closely examining reasoning and assumptions, tracing implications, searching for unintended consequences, and appealing to logical consistency. In these days of 'false news', Socrates would have been exemplary in carefully distinguishing those beliefs that are reasonable and logical from those that lack evidence and rational foundation to warrant our belief. Plato wanted his students to distinguish between what 'appears to be' from what they 'really are' beneath the surface, to come out of the cave and be responsive to objections. Such critical thinking, resilience, and problem solving that many are claiming to be the defining attributes of the 21st century should instead be called 5th century BC skills.

Similarly, there are many schools running critical, creative, and learning strategy classes; countries that require collaborative problem solving courses to be built into their curricula, and numerous web sites claiming to 'train the brain'. There are many myths about the implications of neuroscience into learning, and in many cases these are akin to sowing a thousand weeds. It is an empirical question whether learning strategies can be effectively taught separately from content, and which of these strategies is more effective in transforming a student's learning and achievement outcomes. The current industry of apps, web sites, and interactive games often ignores the eons of research on learning, as illustrated by the chapters in this book.

It is also our observation that the teaching of 'learning' has diminished to near extinction in many teacher education programs. At best, there are passing references to Vygotsky's zone of proximal development; the use of constructivism (but this is normally presented as method of teaching rather than a theory of learning; (see Bereiter & Scardamalia, 2014); the development of learning progressions (in which adults generally prescribe a scope and sequence to be pursued, despite this often being independent of how students actually progress); and an over dominance on how to teach content and less focus on the methods of learning this content. When we ask teachers to name at least two theories of learning, the most common default response is Piaget or constructivism. Worse, those methods known to be failures are often referenced: learning styles, training the brain as a muscle, giving students control over learning (rather than teaching them how to have this control, and understanding what 'control' means). We reviewed over 1,000 hours of transcripts of teaching lessons for example to illustrate how some teachers teach students how to learn but, other than some questioning the student about how they got to that answer, we failed to find any.

In our workshops, we ask teachers and their students 'how do you think' and most struggle. The point is that we do not have a rich language of thinking despite the twenty-first century claims, and despite the rich knowledge and theories of learning. Often, the comment is 'I learn this way' whereas, as will be seen in this chapter, the attribute of successful learners is their flexibility to apply the optimal strategies at the optimal time. Other defining attributes include adaptiveness – knowing multiple ways to learn; knowing when to use a strategy and when to not use this strategy; knowing what to do when we do not know what do. A return to understanding 'learning' is needed, and the recent development of the 'Science of Learning' and the excitement about relating neuroscience, cognitive psychology, and education promises a worthwhile future. Knowing what learning strategies do and do not work is the science of learning; knowing when, where, and in what combination to use them for any individual learner is the art of teaching.

There is indeed a rich literature in learning strategies and our search located over 400; some were relabeled versions of others, some were minor modifications of others. Indeed creating taxonomies have been a valuable contribution by various researchers. Boekaerts (1997), for example, argued for three types of learning strategies: (1) cognitive strategies such as elaboration, to deepen the understanding of the domain studied; (2) metacognitive strategies such as planning, to regulate the learning process; and (3) motivational strategies such as self-efficacy, to motivate oneself to engage in learning. Dignath, Buettner, and Langfeldt (2008) added a fourth category – management strategies such as finding, navigating, and evaluating resources. Our aim was to locate evidence on the effectiveness of these strategies, to evaluate which moderators were most critical, and to make relative

comparisons of the learning strategies. Perhaps there is a top ten of learning strategies (see Dunlosky et al., 2013), but identifying the moderators and mediators as important, in our view, as identifying the strategies themselves: consequently, this was an underlying theme in our search.

There was the usual iterative consideration of the empirical and theoretical tensions, and in the process of our meta-synthesis, we built a model that helped serve as the coat hanger for understanding the empirical claims. Like all models, it provides a set of conjectures; it aims to provide explanatory power; it helps explain the empirical findings, and to generate future research questions. The model contains a proposed set of explanations, relations, and causal directions, all of which are subject to testing, the evaluation of the degree of corroboration, the investigation of implications and conjectures, and ultimately to the usual rigors of tests of empirical and logical falsifiability. As Popper (1968, p. 280) claimed:

> Bold ideas, unjustified anticipations, and speculative thought, are our only means for interpreting nature … and we must hazard them to win our prize. Those among us who are unwilling to expose their ideas to the hazard of refutation do not take part in the scientific game.'

Hence to our model.

A model of learning

The model comprises the following three components: learner inputs, learning agents, and learning outcomes, and these are depicted in Figure 7.1. The student arrives at a given learning experience with a pre-existing set of personal qualities, abilities, knowledge, and histories, all of which may impact their subsequent learning. We name these inputs and categorize them into either skill (knowledge and ability), will (the student's dispositions that affect learning), and thrill (motivations, emotions, and enjoyment of learning). These three categories also describe the outcomes of the learning process, and mediating inputs and outcomes are the learning agents – those phenomena that facilitate learning, be they direct, pedagogical, intentional, or otherwise: these include success criteria, the environment, and learning strategies. In our model, we propose that these learning agents can impact learning at either a factual-content (surface) level, an integrated and relational (deep) level, and when learning is extended to new situations (transfer). Finally, learning at each of these levels can be distinguished further, depending on whether the student is first encountering or acquiring into new learning, and whether the student is consolidating the learning at the surface and deep stages.

The model proposes that various learning strategies are differentially effective depending on the students' prior knowledge, disposition to learn, motivation to learn (which includes) the degree to which the students are aware of the criteria

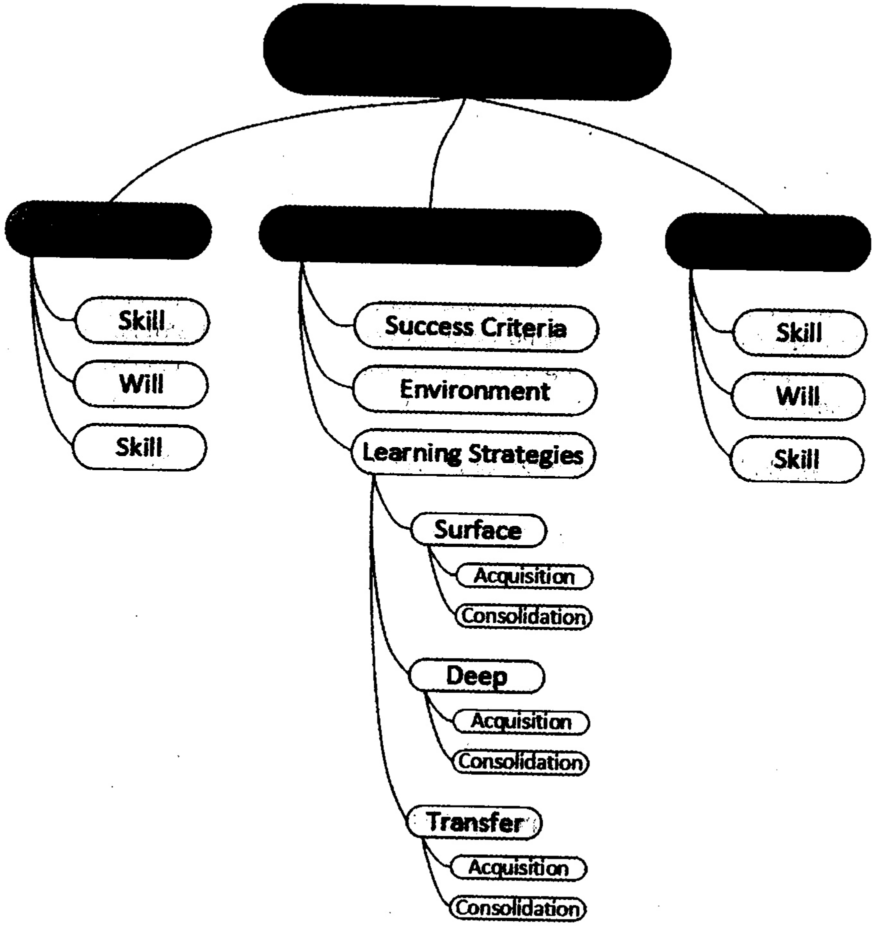

Figure 7.1 **The learning schema.**

of success. The strategies are differentially effective depending on whether the learning relates to ideas and surface level knowledge, to relations and deeper understanding, and to the strategies relating to transferring their knowing and understanding to near and far transfer tasks. Finally, within the surface and deeper phases, the strategies are differentially effecting depending on whether the student is acquiring or consolidating their understanding.

Evidence related to this model is provided via a meta-synthesis based on 18,956 studies from 228 meta-analyses. Only 125 of these meta-analyses reported sample size (N =11,006,839), but if the average (excluding the outlier 7 million from one meta-analysis) is used for the missing sample sizes, the best

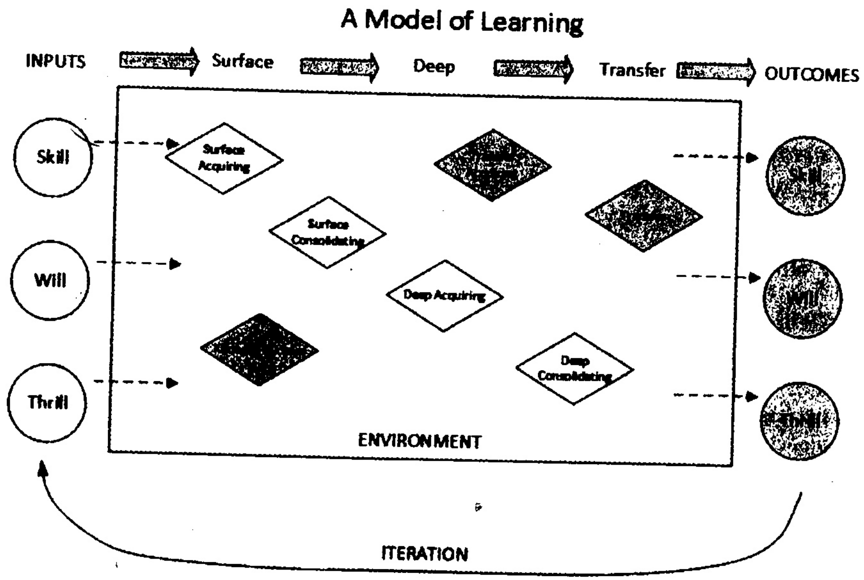

Figure 7.2 **A model of learning.**

estimate of sample size is between 13 and 20 million students. The average effect is 0.53 but there is considerable variance. The details of all phases of the model and results are presented in Hattie and Donoghue (2016; see also Donoghue & Hattie, in review).

Input and outcomes

Figure 7.2 shows the proposed model, including the types and phases of learning described above, depicted with a proposed sequence. Notwithstanding, it should be noted that this sequence is not unidirectional, as in reality learning will occur iteratively, non-linearly, and with much overlap between the phases.

The model starts with three major sources of inputs: the skill, the will, and the thrill. The 'skill' is the student's prior or subsequent achievement, the 'will' relates to the student's various dispositions towards learning, and the 'thrill' refers to the motivations held by the student. In our model, these inputs are also the major outcomes of learning. That is, developing outcomes in achievement (skill) is as valuable as enhancing the dispositions towards learning (will) and as valuable as inviting students to reinvest more into their mastery of learning (thrill or motivations). Each of these inputs, and more obviously the outputs, are desirable learning outcomes – in and of themselves – and are open to being influenced by teaching, both directly and indirectly, both intentionally and unintentionally.

The skill

The first component describes the prior achievement the student brings to the learning task (d=.77). Illeris (2007) claimed that 'the outcome of the individual acquisition process is always dependent on what has already been acquired' (p. 1). Other influences related to the skills students bring to learning include their working memory, beliefs, encouragement, and expectations from the student's cultural background and home.

The will

The will, in contrast, are dispositions, habits of mind, or tendencies to respond to situations in certain ways, and here is where many of the so-called 21st century skills can be placed. The popular dispositions of grit, mindfulness, and growth versus fixed mindsets have low effects (d=.19). This shows how difficult it is to change to growth mindsets, which should not be surprising as many students work in a world of schools dominated by fixed notions – high achievement, ability groups, and peer comparison. Moreover, Dweck (2012) has been careful to note that having a growth mindset is optimal in situations of adversity, helplessness, error, and where failure is a risk. She has also repeatedly noted that there is not necessarily a generic state of 'growth mindset' but one more specific to situations. Indeed, a growth mindset can be a fixed notion! Schwartz, Cheng, Salehi, and Wieman (2016) also noted that these dispositions may be worthwhile for students most at risk for poor academic achievement, and Yaeger et al.'s (2016) intervention only had impact on students in the bottom fifth of achievement. Credé et al. (2016) showed that the core concept in 'grit', often considered a core of growth mindset, is conscientiousness, and it is well documented how hard it is to change this personality disposition.

The thrill

There can be a thrill in learning but for many students, learning in some domains can be dull, uninviting, and boring. There is a huge literature on various motivational aspects of learning, and a smaller literature on how the more effective motivational aspects can be taught. A typical demarcation is between mastery and performance orientations. Mastery goals are seen as being associated with intellectual development, the acquisition of knowledge and new skills, investment of greater effort, and higher-order cognitive strategies and learning outcomes. Performance goals, on the other hand, have a competitive focus: outperforming others or completing tasks to please others. The correlations of mastery and performance goals with achievement, however, are not as high as many have claimed (Carpenter, 2007; Hulleman et al., 2010).

Most modern theories of motivation assume a student needs to be 'pulled or pushed' such as *wanting* to master or *competing* with one's peers. An alternative

and more defensible basis of motivation is the notion of *striving*: recognizing that life does not stand still, and the learner will be 'moving forward' in any event, the important motivation question becomes 'will I do *this* or *that*' (Hoddis, Hattie, & Hoddis, 2016; Peters, 1958). These striving theories of motivation have a higher chance of explaining why students engage in one activity or an alternative (e.g. on or off task). Higgins (2011), for example, argued that we strive for value, control and truth effectiveness, and we do this through promotion or preventive striving; that is we seek evidence for confirming current beliefs in ourselves ('I am a competent or a failure student') or seek evidence disconfirming their current beliefs to thence have self-evidence of the truth effectiveness of their beliefs about themselves as learners (I worked hard and passed this assignment so I am an OK student; see also Swann, 2011). In many senses this is akin to the distinction Popper (1968) makes between confirmation and disconfirmation and helps explain why we continue to do one thing rather than another.

To enact these strivings, Biggs (1993) combined the motivation strivings (why the student wants to study a task) and their related strategies (how the student approaches the task). He outlined three common approaches to learning: deep, surface, and achieving. When students are taking a deep strategy, they aim to develop understanding and make sense of what they are learning, create meaning, and make ideas their own. This means they focus on the meaning of what they are learning, aim to develop their own understanding, relate ideas together and make connections with previous experiences, ask themselves questions about what they are learning, discuss their ideas with others, and compare different perspectives. When students are taking a surface strategy, they aim to reproduce information and learn the facts and ideas – with little recourse to seeing relations or connections between those facts and ideas. When students are using an achieving strategy, they use a 'minimax' notion – minimum amount of effort for maximum return in terms of passing tests, complying with instructions, and operating strategically to meet a desired grade. It is this achieving strategy that seems most related to school outcomes.

The learning agents

Success criteria

As important as the exploration of learning strategies themselves is the study c the mediators of those strategies. A major mediator is the degree to which th learner is aware of the criteria of success of the learning, along with the valu they place on attaining these success criteria. Some students will engage in mos activities regardless; indeed teachers value such compliant students. But man particularly as they move to senior elementary schools, start to question the pu pose, authenticity, and value of investing energies into attaining undesirable unknown outcomes. The time for compliance is over; students value contrc knowing, and understanding more than they value externally defined succe criteria. Students' behaviors become more goal-directed when they are aware of what it means to be successful before undertaking the task. Students who can articulate or are taught these success criteria are more likely to be strategic in their choice of learning strategies, more likely to enjoy the thrill of success in learning, and more likely to reinvest in attaining the criteria of success.

The evidence from the meta-synthesis is that the key component of *Thrill* is having the cognitive flexibility to know when to be deep and surface (d=.70), provided the student does have deep strategies (d=.63) and motivations (d=.75). Having mastery (d=.19) or performance (d=.11) goals have little import. The thrill is increased when students are exposed or invited to co-construct success criteria early in a sequence of instruction (d=1.13). This could be accomplished through teaching students how to develop concept maps (d=.62), develop standards for self-judgment of their work relative to the success criteria (d=.62), and using the Goldilocks principle of 'not too hard, not too boring' (d=.57; see Lomas et al., 2017).

Environment

Underlying all components in the model is the environment in which the student is studying. Many books and internet sites on study skills claim that it is important to attend to various features of the environment such as a quiet room, no music or television, high levels of social support, giving students control over their learning, allowing students to study at preferred times of the day, and ensuring sufficient sleep and exercise.

Despite the inordinate attention, particularly from parents, on structuring the environment as a precondition for effective study, such effects are generally relatively small. It seems to make no difference whether there is background music (d=-.04), whether students have control over learning (d=.02), the time of day to study (d=.12), the degree of social support (d=.12), or the use of exercise (d=.26). Given that most students receive sufficient sleep and exercise, it is perhaps not surprising that these are low effects – of course, extreme sleep or food deprivation are likely to have marked effects on learning. Finally, it is important to note that these data are silent on the question of whether things like music, exercise, and autonomy are desirable learning phenomena in their own right.

The learning strategies

The three phases of learning: surface, deep and transfer

The model highlights the importance of both surface and deep learning and does not privilege one over the other, but rather insists that both are critical. Although the model does seem to imply an order, it must be noted that these are fuzzy distinctions (surface and deep learning can be accomplished simultaneously), but it is useful to separate them to identify the most effective learning strategies. More often than not, a student must have sufficient surface knowledge before moving to deep learning and then to the transfer of these understandings. As Entwistle (1976) noted, 'The verb "to learn" takes the accusative'; that is, it only makes sense to analyze learning in relation to the subject or content area and the particular piece of work towards which the learning is directed, and also the context within which the learning takes place. The key debate, therefore, is whether the learning is directed content that is meaningful to the student, as this will directly affect student dispositions, in particular a student's motivation to learn and willingness to reinvest in their learning.

Acquiring surface learning

Surface learning includes subject matter vocabulary, the content of the lesson, and knowing much more. Successful strategies include integrating the new ideas with prior knowledge (d=.93), outlining and transforming (d=.85), and summarization and organizing (d=.63). Note, at this phase, memorization has a very low effect (d=.06). It is the skill to learn how to sift out the wheat from the chaff, to develop a coat hanger on which to frame the various bits of information that matter the most at the phase. Note, what matters is teaching students these skills of outlining and summarizing, and not merely giving them a teacher-prepared outline or summary.

Consolidating surface learning

Once a student has begun to develop surface knowledge, it is then important to encode it in a manner such that it can retrieved at later appropriate moments. This encoding involves two groups of learning strategies: the first develops storage strength (the degree to which a memory is durably established or 'well learned'), and the second develops strategies that develop retrieval strength (the degree to which a memory is accessible at a given point in time; Bjork & Bjork, 1992). Encoding strategies are aimed to develop both, but with a particular emphasis on developing retrieval strength. Both groups of strategies invoke an investment in learning, and this involves 'the tendency to seek out, engage in, enjoy, and continuously pursue opportunities for effortful cognitive activity (von Stumm et al., 2011). Although some may not 'enjoy' this phase, it does involve a willingness to practice, to be curious, and to explore again, and a willingness to tolerate ambiguity and uncertainty during this investment phase. In turn, this requires sufficient metacognition and a calibrated sense of progress towards the desired learning outcomes. Strategies include deliberate practice testing (d=.77), the skill to receive and use feedback (d=.71), spaced versus mass practice (d=.60), and rehearsal and memorization (d=.73). Incidentally, it is worth noting that the effect of memorization in this consolidation phase (0.73) is starkly higher than in the Acquiring Surface phase (d=.06) – demonstrating the differential effectiveness of learning strategies depending on the phase and type of learning as depicted in the model.

Acquiring deep learning

Students who have high levels of awareness, control, or strategic choice of multiple strategies are often referred to as 'self-regulated' or having high levels of metacognition. Hattie (2009) described these self-regulated students as 'becoming like teachers', as they had a repertoire of strategies to apply when their current strategy was not working, and they had clear conceptions of what success looks like. Pintrich (2000, p. 547) described self-regulation as 'an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by their goals and the contextual features in the environment'. These students know the what, where, who, when, and why to use which learning strategies: they know what to do when they do not know what to do. Successful self-regulation strategies include elaboration and organization (d=.75), strategy monitoring (d=.71), and elaborative interrogation (asking 'why' questions, d=.42).

Consolidating deep learning

Once a student has acquired surface and deep learning to the extent that it becomes part of their repertoire of skills and strategies, then there is evidence of 'automatization'. In many senses this automatism becomes an 'idea', and so the cycle continues from surface idea to deeper knowing that then becomes a surface idea, and so on. At this consolidating phase, the power of working with others is most apparent, and high levels of trust are needed so that students can 'think aloud'. It is through such listening and speaking about their learning that students and teachers realize what they do deeply know, what they do not know, and where they are struggling to find relations and extensions. The successful strategies include seeking help from peers (d=.83), classroom discussion (d=.82), evaluation and reflection (d=.75), talking to others about self-consequences (d=.70), problem-based learning with others (d=.68), self-verbalization and self-questioning (d=.64), being a peer tutor and learning to teach others (d=.54), self-explanation (d=.50), self-monitoring (d=.45), and self-verbalizing the steps in problems (d=.41).

Transfer

There are skills involved in transferring knowledge and understanding from one situation to a new situation. Indeed some have considered that successful transfer could be thought as synonymous with learning (Perkins & Salomon, 2012). There are many distinctions relating to transfer: near and far transfer, low and high transfer, transfer to new situations and problem solving transfer, and positive and negative transfer (Bereiter & Scardamalia, 2014). Marton (2006) argued that transfer occurs when the learner learns strategies that

apply in a certain situation such that they are enabled to do the same thing in another situation when they realize that the second situation resembles (or is perceived to resemble) the first situation. He claimed that not only sameness, similarity, or identity might connect situations to each other, but also small differences might connect them as well. Learning how to detect such differences is critical for the transfer of learning. As Heraclitus claimed, no two experiences are identical; you do not step into the same river twice. Indeed, the effect of detecting similarity and differences between the current and new problem is high (d=1.32), as is seeing patterns between old and new situations (d=1.14).

Rather than solving one problem then rushing to solve the next one, a student is well advised to pause, then compare and contrast each problem: indeed this seems key to the transfer process. The model (see Figure 7.2) proposes that Transfer is a skill that, like other skills, can be taught. Consequently, it depicts the falsifiable hypothesis that the learning of transfer may have Acquisition and Consolidation phases, and that strategies for learning transfer may be differentially effective depending on which of these phases is applicable. Despite an absence of evidence for or against this notion, it is worth noting that this idea arose directly from the process of explicating the original model (Hattie & Donoghue, 2016), demonstrating one important utility of conceptual models: the generation of falsifiable hypotheses worthy of investigation.

Discussion and conclusions

There is much debate about the optimal strategies of learning, and indeed we identified over 400 terms used to describe these strategies. Our initial aim was to rank the various strategies in terms of their effectiveness but this soon was abandoned. There was too much variability in the effectiveness of most strategies depending on when they were used during the learning process, and thus we developed a model of learning to explain and generate predictions about optimal learning strategies and their moderators. Later work investigates methods to assess the various strategies, and to identify the optimal teaching methods related to improving students' knowledge and adaptive use of the strategies. Like all models, Figure 7.2 is a conjecture, it aims to say much, and it is falsifiable. There are ten major implications.

First, the model posits that learning must be embedded in some content (something worth knowing) and thus the current claims about developing 21st century skills sui generis are most misleading. These skills often are promoted as content free that can be developed in separate courses (e.g. critical thinking, study skills, resilience, growth mindsets). Our model, however, suggests that such skills are likely to be best developed relative to some content. There is no need to develop learning strategy courses, or teach the various strategies outside the context of the content. Instead, the strategies should be an integral part of the teaching and learning process, and can be taught within this process.

Second, the model includes three major inputs and outcomes. These relate to what the students bring to the learning encounter (skill), their dispositions about learning (will), and their motivations towards the task (thrill). Connecting with prior knowledge, enabling confidence and reducing anxiety, and exposing the criteria of success early in the learning make the most difference. The optimal is when students are aware of a transparent progression from what they currently know, are able to do, and what they care about to the criteria of success. There needs to be thrill in learning, and hence the drill and skill models, the dominant 'tell and practice' model of teaching, and the over-saturation of 'knowing lots' prescribed by so many curricula documents may mitigate against the presence of this thrill of learning. Like playing many video games, it is the thrill of learning and not the completion of tasks that excite most students – it is not gaining the golden ticket, completing and handing in the work, or getting to the final level that matters; it is the thrill of learning how to play the game. Students will engage in very challenging tasks if the learning requirements are seen to be attainable (with practice and feedback) and not boring; hence the Goldilocks principle of 'Not too hard but not too boring' (Lomas et al., 2017).

Third, the model proposes that effective learning strategies will be different depending on the phase of the learning – the strategies will be different when a student is first acquiring the matters to be learnt compared with when the student is embedding or consolidating this learning. That is, the strategies are differentially effective depending on whether the learning intention is surface learning (the content), deep learning (the relations between content), or the transfer of the skills to new situations or tasks. In many ways this demarcation is arbitrary (but not capricious) and more experimental research is needed to explore these conjectures. Although the model is presented as linear it is noted that there can be much overlap in the various phases. For example, to learn subject matter (surface) deeply (i.e. to encode in memory) is helped by exploring and understanding its meaning; success criteria can have a mix of surface and deep, and even demonstrate the transfer to other (real world) situations; and often deep learning necessitates returning to acquire specific surface level vocabulary and understanding. In some cases, there can be multiple overlapping processes: learning is iterative and non-linear.

Fourth, the essence of successful use of learning strategies relates to the timing and adaptive choice of strategy. While it is possible to nominate the top 10 learning strategies, the more critical conclusion is that the optimal strategies depend on where in the learning cycle the student is located. This strategic skill in using the strategies at the right moment is akin to the message in the Kenny Rogers song – you need to 'know when to hold 'em, know when to fold 'em'. For example, when starting a teaching sequence, it is most important to be concerned that students have confidence that they have a reasonable chance to attain the success criteria, see value in the lessons and can relate it to prior learning and future desired skills, and are not overly anxious about the skills to be mastered. Providing them early on with an overview of what successful learning in the lessons will look like (knowing the success criteria) will help them reduce their anxiety, increase their motivation, and build both surface and deeper understanding.

To acquire surface learning, it is worth knowing how to summarize, outline, and relate the learning to prior achievement; and then to consolidate this learning by engaging in deliberate practice, rehearsing over time and learning how to seek and receive feedback to modify this effort. To acquire deep understanding requires the strategies of planning and evaluation, and learning to monitor the use of one's learning strategies; and then to consolidate deep understanding calls on the strategy of self-talk, self-evaluation, and self-questioning, and seeking help from peers. Such consolidation requires the learner to think aloud, learn the 'language of thinking', know how to seek help, self-question, and work through the consequences of the next steps in learning. The transfer of learning to new situations involves knowing how to detect similarities and differences between the old and the new problem or situations. There is much less support for standalone learning strategy developing generic working memory skills, critical or creative thinking classes. These classes can have an impact, but there is little evidence that they improve a student's transfer to new content domains. The claim, for example, is that working memory is strongly related to a person's ability to reason with novel information – and needs therefore to be developed within the context of that information.

Fifth, strategies are differentially effective depending on the phase of learning – early exposure (Acquisition) or strengthening and reinforcing (Consolidation). This distinction is far from novel. Shuell (1990), for example, distinguished between initial, intermediate, and final phases of learning. In the initial phase, the students can encounter a 'large array of facts and pieces of information that are more-or-less isolated conceptually ... there appears to be little more than a wasteland with few landmarks to guide the traveler on his or her journey towards understanding and mastery'. Students can use existing schema to make sense of this new information, or can be guided to have more appropriate schema (and thus experience early stages of concept learning and relation between ideas – that is, deep learning) otherwise the information may remain as isolated facts, or be linked erroneously to previous understandings. At the intermediate phase, the learner begins to see similarities and relationships among these seemingly conceptually isolated pieces of information. The fog continues to lift but still has not yet burnt off completely. During the final phase, the knowledge structure becomes well integrated and functions more autonomously, unconsciously, and automatically, and the emphasis is more on performance or exhibiting the outcome of learning.

The sixth set of claims relate to the distinction between surface, deep, and transfer of learning. Critically the model does not assume 'surface is bad' and 'deep is good', nor does it privilege one over the other. Instead it presumes both are critical: surface feeds into deep, and deep can then feed into transfer, or even back to surface – it is a matter of emphasis, when and for what purpose. As Illeris (2007) noted, all learning includes three dimensions: 'the content dimensions of knowledge, understandings, skills, abilities, working methods, values, and the like; the incentive dimension of emotion, feelings, motivation, and volition; and the social dimension of interaction, communication, and cooperation' (p. 1). Certainly the strategies found to be most effective relate to emotional, social, and the cultural dimensions as much as to knowing and understanding. Building proficiency of 'capacity change' – not merely due to aging or development processes – is a main responsibility of our educational institutions, and the increasing need to improve surface; deep, transfer along with competencies to respect oneself and others, along with working in teams and interpreting to others what one knows is now all the more critical. It is the proportion, at the right time, for the right gains, for the right reasons of surface and deep that matter much more than one or the other. The model proposes a direction as to 'what is learning?' – it is the outcome from moving from surface to deep to transfer. Only then will students be able to go beyond the information given to 'figure things out', which is one of the few untarnished joys of life (Bruner, 1996). One of the greatest triumphs of learning is what Perkins (2014) calls 'knowing one's way around' a particular topic or 'playing the whole game' of history, mathematics, science, or whatever. This is a function of knowing much and then using this knowledge in the exploration of relations and to make extensions to other ideas, and being able to know what to do when one does not know what to do (the act of transfer).

Seventh, strategies for transfer are known and can be taught. It is so important to teach students to pause and detect the similarities and differences between previous tasks and the new one, compare and contrast the similarities in the previous and new problem before attempting to answer a new problem. Too many (particularly struggling) students over-rehearse a few learning strategies (e.g. copying and highlighting) and apply them in situations regardless of the demands of new tasks. Certainly, the fundamental skill for positive transfer is stopping before addressing the problem and asking about the differences and similarities between the old and new task. This ability to notice similarities and differences over content is quite different for novices and experts, and we do not simply learn from experience but we also learn to experience (Marton, Wen, & Wong, 2005; Bransford et al., 1999). Preparation for future learning involves opportunities to try our hunches in different contexts, receive feedback, engage in productive failure, and learn to revise our knowing based on feedback. The aim is to solve problems more efficiently, and also to 'let go' of previously acquired knowledge in light of more sophisticated understandings – and this can have emotional consequences: 'Failure to change strategies in new situations has been described as the tyranny of successes' (Robinson, Stern, & Stern, 1997, p. 84). It is not always productive for students to try the same thing that worked last time. Hence there may need to be an emphasis on knowledge-building rather than knowledge-telling, and systematic inquiry based on theory-building and disconfirmation rather than simply following processes for how to find some result.

Eighth, the model can help explain why some popular teaching methods, such as most programs based on 'deep learning' have low rates of success. For example, there have been 11 meta-analyses relating to problem-based learning based on 509 studies, leading to, on average, a small effect (d=.15). It hardly seems necessary to run another problem-based program (particularly in first-year medicine, where four of the meta-analyses were completed) to know that the effects of problem-based learning on outcomes are small. The current model helps explain this seemingly anomalous finding. Problem-based learning is too often introduced before the students have sufficient surface knowledge to thence problem solve. When problem-based learning is introduced after developing sufficient surface knowing, (e.g. in later medical years), the effects increase (Albanese & Mitchell, 1993; Walker & Leary, 2009).

Ninth, it may be worthwhile to map various teaching strategies to the phases of the model. We reviewed the 300+ teaching strategies outlined in Marzano (2016) and determined those which most related to each phase of the model. For surface acquisition the most optimal teaching strategies include notebook review, pictorial notes, summarizing; for surface consolidation use assignment revision, frequent structured practice, think logs, two-column notes, revising knowledge using the five basic processes; for deep acquisition use elaborative interrogation, examining support for claims, generating qualifiers, identifying errors of attack, identifying errors of faulty logic, presenting the formal structure of claims and support, providing backing, and worked examples; for deep consolidation use grouping for active processing, inside outside circle, peer feedback, peer response groups, peer tutoring, student tournaments, think-pair-share, and cumulative review; and for transfer use classification charts, dichotomous keys, sorting, matching, categorizing, and student-generated classification patterns. The only strategy that appears to cross the various phases is the Jigsaw method, which has very high overall effect sizes (Batdi, 2014, d=1.20).

Tenth, and as much a summary, if a success criterion is the retention of accurate detail (surface learning) then lower-level learning strategies will be more effective than higher-level strategies. However, if the intention is to help students understand context (deeper learning) with a view to applying it in a new context (transfer), then higher-level strategies are also needed. An explicit assumption is that higher-level thinking requires a sufficient corpus of lower level surface knowledge to be effective – one cannot move straight to higher level thinking (e.g. problem solving and creative thought) without sufficient level of content knowledge. There are learning strategies that maximize the various parts of the learning cycle: students need to create their own set of known learning strategies, be able to meta-cognitively choose a strategy for a given learning experience, be able to evaluate the effectiveness of that strategy, and finally to have the cognitive flexibility to change strategies if one proves ineffective. This fundamental skillset that recognizes learning as a complex, non-linear and time-sensitive phenomenon can and should be taught.

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