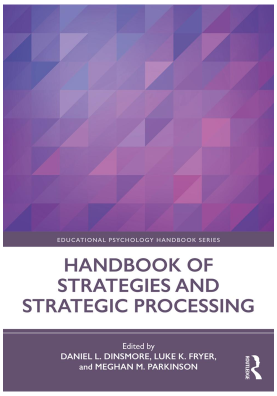

Handbook of Strategies and Strategic Processing

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Levels of Strategies and Strategic Processing

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LEVELS OF STRATEGIES AND STRATEGIC PROCESSING

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Strategies and the processing that accompanies the use of strategies is generally considered to be dynamic and multidimensional (*Dinsmore, 2017; Dinsmore, Fryer, & Parkinson, this volume). Additionally, the manner in which researchers have conceptualized and operationalized strategies and strategy use has resulted in distinctions between strategies. These distinctions may influence an individual's subsequent performance on the task or problem in which the individual employed a particular strategy. Also, these distinctions may encompass whether those strategies are domain specific or domain general (Dumas, this volume) or the differences between whether those strategies are cognitive, metacognitive, or self-regulatory. The crux of this chapter will be to consider different levels of strategic processing – with a focus on surface-level (i.e., those strategies aimed at understanding or solving a problem; Dinsmore & Alexander, 2106), deep-level (i.e., those strategies aimed at transforming a problem; Dinsmore & Alexander, 2016), metacognitive (i.e., those strategies aimed at monitoring and controlling one's own thinking; Garner, 1988), and self-regulatory strategies (i.e., those strategies aimed at regulating cognition, motivation, or affect; Pintrich & De Groot, 1990) – and how this processing influences individuals' performance in a task or while solving a problem.

Although this task may seem somewhat simplistic, a direct connection between levels of strategy use and performance has been anything but clear (e.g., Block, 2009; Cano, 2007). The long-held notion that those who employ deeper-level strategies over surface-level strategies will perform better (e.g., Phan, 2009b) has not come to fruition across multiple theoretical frameworks or methodologies (e.g., *Asikainen & Gijbels, 2017; *Dinsmore, 2017). Rather, it appears as if there are other mediating and moderating factors that play into how strategy use and performance are linked.

Fortunately, there now exist numerous reviews of the literature, both systematic and non-systematic, that help the field take stock of some of the facets of strategy use – such as levels of processing – and how these other factors might influence performance in conjunction with that strategy use. So, rather than undertake another review to flesh out these issues, we have decided to conduct a review of existing reviews in this relatively mature field of study. A systematic review of reviews is similar to a systematic review in that it is a reproducible review, but rather than reviewing empirical studies, the search criteria identify existing reviews of the literature (see Mills & Fives, 2018, for another example). This review will allow us to provide a picture of how levels of processing have been considered historically, how those historical notions have developed in the current state of the literature, and what limitations remain. These insights will then allow us to provide suggestions for both experienced and new scholars in this area of research, as well as provide practical implications for policymakers and practitioners.

To guide this review of reviews, we pose the following questions:

1. How have theoretical levels of processing been conceptualized and operationalized in literature reviews of strategic processing?
2. Have these levels of processing been shown to influence performance in any systematic manner across these reviews?
3. What other individual and contextual factors have these reviews concluded to be important factors to consider in the relation between levels of processing and performance?

METHODS FOR THE REVIEW

Review Selection

To select relevant reviews for this review we searched PsycINFO and Google Scholar using the terms "strategic processing review" and "cognitive strategy review". These searches resulted in 29 studies that we identified as potential reviews to include in the pool. Additionally, we identified reviews that we were aware of that were not identified in the database search that fit the review criteria. From there, studies were further hand searched by abstract or article to determine whether they would help provide evidence to answer the guiding question for this review of reviews. In this stage we reduced the number of reviews to our final pool, which encompasses 15 total reviews. For example, although *Pintrich's (2004) article, "A conceptual framework for assessing motivation and self-regulated learning in college students," was identified in our search parameters, a thorough inspection of the article indicated that it was primarily an articulation of a theoretical framework, rather than a review of the literature.

We purposefully did not include levels of processing in the search criteria to examine if this facet of strategies in reviews of strategies and strategic processing was scrutinized. The inclusion and conceptualization of levels of processing was subsequently an idea we tracked in our data table, which we will now describe.

Tabling of the Reviews

To gather evidence from these reviews we created a table that recorded the inclusion and conceptualization of levels of processing, whether and how the measurement of levels of processing was addressed, the context or contexts in which levels of processing was examined, which learner individual differences were examined, and what conclusions the review drew regarding the link between levels of strategic processing and performance outcomes. The table is primarily descriptive – rather than a reductive coding process – to provide readers with as much information as possible. In other words, we aim here to provide a resource for those interested in these ideas to find relevant reviews in which they can explore these ideas further.

To begin tabling we first discussed each column in the table and what we thought relevant evidence from a review might look like. Second, we jointly tabled two reviews to ensure that evidence we drew from the reviews into the table was congruent. After tabling and discussing those two reviews, we each independently tabled two additional reviews. Following this independent tabling, we compared the evidence from each of these tables and determined they were sufficiently congruent to divide the remaining reviews between the two of us to table.

FINDINGS AND DISCUSSION OF THE REVIEW

The full table with the descriptive evidence from each review is presented in Table 3.1.

Each of the reviews is listed in the references section with an asterisk preceding the reference. The findings from the reviews in the table will be presented and discussed in accordance with the three guiding questions for the chapter – conceptualization and operationalization of levels of processing, systematic effects of levels of processing on performance, and the influences of contextual and individual factors that mediate or moderate the relation between levels of processing and performance.

Conceptualization and Operationalization of Levels of Processing

Conceptualization. With regard to how levels of processing were conceptualized in these reviews we found that ten of the reviews explicitly discussed levels of processing, while five did not. Of the five reviews that did not discuss levels of processing (*Afflerbach, Pearson, & Paris, 2008; *Alexander & Judy, 1988; *Ashcraft, 1990; *Paris, 1988; Paris, Lipson, & Wixson, 1983), two of these reviews (*Afflerbach et al., 2008; *Alexander & Judy, 1988) were concerned with the definition of a strategy. For instance, Afflerbach and colleagues addressed the confusion between the terms *skill* and *strategy* making the claim that confusion between these two terms could result in less effective instruction for children and adolescents.

Of the reviews that did address levels of processing there were a variety of frameworks from which these levels were addressed. Four of the reviews addressed levels of processing from the perspective of the development of expertise. These perspectives have been forwarded by Alexander and colleagues (Alexander, Grossnickle, Dumas, & Hattan, 2018; *Dinsmore, 2017; *Dinsmore & Alexander, 2012; *Dinsmore, Hattan, & List, 2018). In each of these reviews, conceptualizations of deep- and surface-level processing (strategies to understand the problem versus transforming them respectively) is informed by Alexander's Model of Domain Learning (MDL; Alexander, 1997, 2004). In the MDL, surface-level strategies are those strategies designed to better understand and solve a problem, whereas deep-level strategies are those strategies designed to transform a particular problem. The MDL predicts that those in acclimation (i.e., novices) would rely primarily on surface-level strategies, whereas experts

Table 3.1 Pooled Studies and Codings

Citation	Number of Studies	Conceptualization/Level	Measurement/ Level	Context (i.e., domain, setting)	Task	Learner Ind Diff	Process-Outcome Links
Afflerbach (2008)	N/A	Examined differences between skills and strategies, explicitly looked at definitions of skills/strategies. This article is all about conceptualizing skills and strategies.	N/A	Reading.	N/A	N/A	
Alexander, Graham, and Harris (1998)	N/A	Defines strategies as being procedural, purposeful, effortful, willful, essential, and facilitative. Strategies as a type of procedural knowledge. Contrasts strategies from skillful behavior. Strategies as domain general, domain specific, or task specific. Includes metacognition, self-regulation, learning and instructional strategies.	N/A	Ways teachers can influence strategy growth: explicitly teaching relevant strategies and creating environments in which strategies are required, valued, and rewarded.	Looks at task variables such as nature of the domain, time constraints, mode of response, and perceived value of the task.	Knowledge, motivation, mindfulness, automaticity (does this count) and other individual differences such as short-term memory.	It is implied that being strategic will result in better outcomes from learners, but this is not explicitly examined.
Alexander, Grossnickle, Dumas, and Hattan (2018)	N/A	Skills v. strategies. Types of strategies: domain general and specific; deep v. surface processing; cognitive and metacognitive. Then also mentions meta-strategies, relational reasoning, online learning.	Mentions self-report, assigning conditions, think alouds, eye tracking, and neurophysiological methods	Includes a description of strategies in online settings, as well as strategies in the classroom.	N/A	Considers epistemic beliefs, motivation, and emotion.	Makes some loose links between strategies and learning.

Citation	Number of Studies	Conceptualization/Level	Measurement/ Level	Context (i.e., domain, setting)	Task	Learner Ind Diff	Process-Outcome Links
Alexander and Judy (1988)	N/A	Domain general or specific. Found definitional issues in the studies. No mention of deep v. surface.	N/A	Looked at studies that focused on a particular domain (although found that the studies mentioned a weak articulation of the content). Mentions the importance of social-contextual factors. Found that most studies had participants of college-age or older.	N/A	Knowledge was discussed at length since the focus was on the interaction between domain-specific and strategic knowledge. Also mentions the importance of motivation and social-contextual factors.	Draws the conclusion that both domain and strategic knowledge are central to learning.
Ashcraft	N/A	Strategy defined as how a task is performed mentally. Focus on mental arithmetic. Mentioned that students can use more than one strategy at once. Strategic processes become more automatic.	N/A	Math.	Arithmetic tasks.	N/A	Performance becomes more rapid and accurate as students develop.
Asikainen and Gijbels (2017)	43	Directly examined deep v. surface-level processing.	Looks at self-report measures: ETLA, ASSIST, SPQ, interviews, etc.	Only looked at higher education, longitudinal studies. Domain-specific (several higher education domains were included such as biology, economics, hospitality, etc.).	N/A	Initial approaches.	Ambiguous.

(*Continued*)

Table 3.1 (Continued)

Citation	Number of Studies	Conceptualization/Level	Measurement/ Level	Context (i.e., domain, setting)	Task	Learner Ind Diff	Process-Outcome Links
Dinsmore (2017)	134	Surface, deep, metacognitive/ self-regulatory.	Examined how quantity, quality, and conditional use were measured.	Reading (45%), mathematics (18%), domain general (17%), science (10%).	Well structured (69%) versus ill structured (24%), both (7%).	Learner goals.	Quality and conditional use explain performance more consistently than simply frequency of strategy use; and numerous person and environmental factors shape the degree to which certain strategies are effective for certain learners.
Dinsmore and Alexander (2012)	221	Directly examined conceptions of levels of processing; explicitly 41.4%, implicitly 50%, and absent 8.6%.	Directly measured levels of processing for studies; 48% self-report, 28.3% by condition; 14.3% coding scheme, 8.1% absent; .9% behavior; .4% by outcome.	Most studies were domain genera (n=117) followed by physical/life science (n=38) and social science (n=36).	60% were task based and 40% were not.	N/A	Mixed/ambiguous links.
Dinsmore, Hattan & List	17	Surface level, deep, metacognitive/ self-regulatory.	Direct observation (1 study), online self-report (24%), offline self-report (71%).	Physical or life science (24%), social sciences (47%), performing arts, physical/ kinesthetic. Generally asked to read rather than tasks specific to the domain.	Lumped task and outcome together – coded as ill-defined (24%) or well-defined (71%).	Stage of development (71% undergraduate students), MDL stage (94% acclimation), domain knowledge, topic knowledge, individual interest, situation interest.	Direct links to performance.

Citation	Number of Studies	Conceptualization/Level	Measurement/ Level	Context (i.e., domain, setting)	Task	Learner Ind Diff	Process-Outcome Links
Hattie & Donoghue	228 meta-analyses	Surface, deep, and transfer with an acquiring and consolidation phase for the surface and deep levels.	N/A	Wide variety.	Wide variety.	Degree to which students understand criteria for success influences strategy selection.	The results indicate that there is a subset of strategies that are effective, but this effectiveness depends on the phase of the model in which they are implemented. Further, it is best not to run separate sessions on learning strategies but to embed the various strategies within the content of the subject to be clearer about developing both surface and deep learning, and promoting their associated optimal strategies and to teach the skills of transfer of learning.
Najmaei & Sadeghinejad	N/A	Metacognition as a more abstract level than cognition.	N/A	Business/ marketing.	N/A	N/A	Suggests future directions to link managers' decisions to strategies they use.
Paris (1988)	N/A	Using metaphors to describe learning strategies – Craik and Lockhart's depth versus Anderson "spread of activation" are discussed.	N/A	N/A	N/A	Levels of expertise are discussed.	N/A

(*Continued*)

Table 3.1 (Continued)

Citation	Number of Studies	Conceptualization/Level	Measurement/ Level	Context (i.e., domain, setting)	Task	Learner Ind Diff	Process-Outcome Links
Pintrich (1999)	N/A	Surface, deep following Weinstein and Mayer, metacognitive, self-regulatory. Pintrich, Wolters, and Baxter (1999) have suggested that metacognitive knowledge be limited to students' knowledge about person, task, and strategy variables. Self-regulation would then refer to students' monitoring, controlling, and regulating their own cognitive activities and actual behavior.	N/A	N/A	N/A	Motivational beliefs (self-efficacy, task value, goal orientation).	N/A
Vermunt and Donche (2017)	44 learning patterns studies in which the ILS is used	Deep, stepwise, and concrete strategies, regulation strategies.	All used the Inventory of Learning Styles (ILS).	Teaching strategies, perception of the learning environment, disciplinary differences.	Discussion is much broader than task.	Personality, academic motivation, goal orientation, attributions of academic success, self-efficacy, effort, epistemological and intelligence beliefs, prior education, age, and gender.	Ties the use of strategies to better performance more at the course and semester level rather than a specific task or performance.

would increasingly rely on deep-level strategies and less on surface-level strategies (cf. *Dinsmore et al., 2018). Thus, the MDL does not predict that quantity of strategies should relate directly to performance. Rather, the level or type of strategy could be explained by the individual's development of expertise in a particular domain – such as mathematics – and that that use of the appropriate strategy for that level of expertise should better predict performance in that domain. For example, Dinsmore and Alexander (2016) empirically tested this notion by examining how levels of processing influenced performance on an astronomy task. Those who had low prior knowledge (one of the hallmarks of being a novice) did not perform well using primarily deep-level strategies, whereas those with more prior knowledge performed better on the outcome task using more deep-level strategies. For instance, participants who tried to use elaborative strategies (using one's own prior knowledge to add information in addition to what the author wrote) while reading the text passage in the study only comprehended that passage better when they possessed higher levels of background knowledge. In other words, in these cases, elaborating on a topic when you have little or no prior knowledge – or worse, inaccurate knowledge – can make comprehension *more* difficult.

Two reviews relied instead on the Learning Patterns framework (*Asikainen & Gijbels, 2017; *Vermunt & Donche, 2017). The Learning Patterns framework has evolved quite a bit over time (Richardson, 2015) but began with quasi-experimental investigations by Marton and Säljö (1976a, 1976b). These investigations examined the role that expected assessments changed how individuals processed information for studying. For instance, if the task assessment for a text passage was to memorize important details of the text, individuals would be expected to use surface-level strategies such as rehearsal. Those individuals who were asked to interpret what the text meant would be expected to use deep-level strategies such as making inferences about the message the author is trying to convey. Although Marton and Säljö were examining these effects at the task level, much of the current research using SAL examines students' processing at the course or even semester level. This is evident in *Vermunt & Donche's (2017) review in which he examined a popular instrument used to measure levels of processing in SAL – the Inventory of Learning Styles (ILS; Vermunt, 1998). It should be noted that the levels in this theory go beyond simply surface and deep level with Biggs (1987) adding an *achieving* level as well. Similarly, *Asikainen and Gijbels (2017) also examined self-report instrument yet expanded beyond the ILS and included a wider variety of self-report instruments.

Three reviews did not examine levels of processing with regard to deep and surface; rather these reviews examined cognitive versus metacognitive and self-regulatory levels (*Alexander, Graham, & Harris, 1998; *Najmaei & Sadeghinejad, 2016; Pintrich, 1999). *Alexander et al. (1998) and *Najmaei and Sadeghinejad (2016) relied primarily on Flavell's (1976) conceptualization of metacognition to frame the differences between cognitive and metacognitive strategies. Pintrich (1999), on the other hand, used his self-regulated learning (SRL) framework (Pintrich, 2000) which encapsulated cognitive, metacognitive, self-regulatory, and affective strategy use during performance. Although no such current review of SRL strategies exists to our knowledge, the use of SRL to investigate strategy use is typified by the work of Azevedo, Greene, and colleagues (Greene & Azevedo, 2009; Taub, Azevedo, Bouchet, & Khosravifar, 2014).

For example, Deekens, Greene, and Lobczowski (2018) used an SRL framework to investigate individuals' self-regulatory strategy use (and the levels they defined within that framework) across two academic domains – history and science. Differences between the metacognitive and self-regulatory levels are explored in depth in Dinsmore, Alexander, and Loughlin's (2008) systematic review of those constructs.

An outlier to reviews within the three frameworks previously mentioned was *Hattie and Donoghue's (2016) meta-analysis, which was based on and refined from Hattie's Visible Learning framework (Hattie, 2008). Hattie's visible learning is the perspective that students learn best when they become their own teachers – through, among other ideas, better constructed feedback for students to use (e.g., Hattie & Clarke, 2018). Although this framework is not as tightly constructed as the MDL or SAL – it does not contain the specific mechanisms of how deep and surface strategies influence learning – *Hattie and Donoghue (2016) meta-analysis draws primarily from information-processing views of learning (e.g., Klahr & Wallace, 1976).

Operationalization. Six of the tabled reviews specifically examined the measurement of levels of strategic processing. Two of these reviews were focused solely on retrospective self-report measures (*Asikainen & Gijbels, 2017; *Vermunt & Donche, 2017). Retrospective self-report refers to measures that survey the use of strategies after the task or activity has taken place. As the use of retrospective self-report has been typical in the SAL literature over the past few decades, the prevalence of these retrospective self-reports is not surprising. Given the examination of processing over longer periods of time – such as a course or a semester – the use of retrospective self-reports is easier and less time intensive than some of the concurrent self-report instruments used elsewhere. For example, Vermunt's ILS (Vermunt, 1998) asks how often students are, "Relating elements of the subject matter to each other and to prior knowledge; structuring these elements into a whole."

Three of the reviews examined measurement of levels of processing beyond retrospective self-report (*Alexander et al., 2018; *Dinsmore & Alexander, 2012; *Dinsmore et al., 2018). Across these three reviews it is apparent that retrospective self-report remains the dominant measure of strategy use with *Dinsmore and Alexander (2012) reporting that almost half (48%) of the studies they reviewed used retrospective self-report, with a higher percentage of retrospective self-report (71%) in their review of studies solely using the MDL. Other methods of measurement included concurrent self-report. Concurrent self-report refers to measurements that collect data about strategic processing *during* a task, rather than after a task. Concurrent measurements of strategy use were primarily the use of the think-aloud protocol, eye tracking, and neurophysiological measures such as functional magnetic resonance imaging. Think-aloud protocols refer to the process of asking individuals to verbally report their strategy use as they are engaged in a task (cf., Ericsson, 2006; e.g., Parkinson & Dinsmore, 2018). Eye tracking measurements are those that examine how movement of the eye relative to a task (typically a text) relates to their processing (cf. Rayner, Chace, Slattery, & Ashby, 2006; e.g., Catrysse et al., 2018). Finally, neurobiological measures, such as functional magnetic resonance imaging (fMRI) or functional near infrared spectroscopy (fNIRS) relates the hemoglobin response (i.e., blood flow) of certain regions of the brain to individuals' processing (cf. Kotz, 2009; e.g., Dinsmore, Macyczko, Greene, & Hooper, 2019).

Further, one review examined different facets of strategy use and levels of processing more specifically. In his review, *Dinsmore (2017) examined measures of the quantity (i.e., how often a strategy was used), quality (i.e., how well a strategy was used), and conditional use (i.e., when a strategy was used) to investigate whether these measures and the facets of strategy use better related to performance outcomes – a topic discussed in a subsequent section. In this review, Dinsmore found that 94% of the studies contained some measure of quantity, while only 24% and 19% of those studies contained some measure of quality and conditional use respectively. Since most of the studies reviewed were self-report, capturing the quantity of that strategy use is fairly straightforward. However, capturing the quality and conditional use of strategies requires more time and labor-intensive measures, such as think aloud protocols (TAPs).

Discussion. At issue in the previous two subsections were the conceptualization and operationalization of levels of strategy use. Taken together, findings from these reviews indicate that issues of conceptualization and operationalization have plagued the educational and psychological literature. With regard to the conceptualization of levels of processing, it is clear that how these levels are conceptualized are at worst not explicitly defined (*Dinsmore & Alexander, 2012), and at best researchers in this area have been using competing frameworks with little impetus to collaborate across these frameworks – with some exception (Dinsmore et al., this volume; Gijbels & Fryer, 2017). As Loughlin and Alexander (2012) pointed out, without conceptual clarity, interpreting the findings of these studies – and their accompanying reviews – becomes difficult.

Exacerbating these conceptual issues are measurement issues. The heavy reliance on retrospective self-report has been highly problematic in related areas of the literature such as metacognition and SRL (Dinsmore et al., 2008; Veenman, Van Hout-Wolters, & Afflerbach, 2006). However, the more time and labor-intensive measurements such as TAP are likely not suitable for large, generalizable, longitudinal studies that leverage larger sample sizes over repeated instances across a semester or year of study. Therefore, there has been – and remains – a difficulty with accurately *and* practically assessing levels of cognitive processing. This issue has left us with either measurements that are quite practical in collecting data from hundreds, even thousands, of students that may or may not accurately reflect their strategic or cognitive processing (i.e., retrospective self-report scales), or measurements that may be more accurate but are difficult to collect and analyze at any large scale.

Systematic Effects of Levels of Processing on Performance

Given the issues regarding conceptualization and operationalization mentioned previously, deriving clear links between levels of processing and performance is difficult. However, across these reviews different conclusions were reached. *Hattie and Donoghue's (2016) meta-analysis and *Vermunt and Donche's (2017) review offered perhaps the most targeted interpretation of this relation. Hattie and Donoghue suggest a subset of strategies that are more effective depending on the phase of learning that individuals are in (i.e., acquiring, consolidating, and transferring). Given the data in *Vermunt and Donche's (2017) review, they made an argument that the ILS could be an effective tool to predict processing over a course or semester, which would in turn predict future performance. However, with the issues of retrospective self-report discussed previously in the chapter, there is some doubt whether these claims are justified. If patterns of processing and strategy use are indeed rather stable over time, this could be the case. On the other hand, if processing and strategy use are more attuned to the conditions of the task and change rapidly, this argument may not hold for those particular instances.

Most of the reviews, however, were rather tenuous in speaking about the relation between levels of processing and performance. These reviews often attempted to qualify the relations between levels of processing and performance further than *Hattie and Donoghue (2016). For instance, *Dinsmore (2017) reported that the relations between levels of processing and performance were higher when quality and conditional use of the strategies were measured rather than simply the quantity of that strategy use. *Asikainen and Gijbels (2017) took a dimmer view of the efficacy of self-report instruments used in the SAL framework to predict performance, noting there was little relation between the learning patterns identified using the SAL perspective and learning performance.

In addition to these views, there is also a third perspective of individuals who do not necessarily believe that a direct link to performance is necessary, which comes predominately from the SRL framework (e.g., Pintrich, 1999). The idea that self-regulatory strategy use is a goal in its own right has been a point of major discussion lately, for example at the European Association for Research on Learning and Instruction (EARLI; Molenaar, 2017). Some of these researchers contend that improved self-regulation, even without being linked to performance, should be emphasized. This position subsumes within it the idea that *all* strategies are self-regulatory – one that needs further investigation. As Alexander pointed out in her expositions of the MDL (e.g., Alexander, 1997; 2004), strategies become increasingly metacognitive as one progresses toward higher levels of expertise. Especially in the stage of acclimation (the first stage on the path toward expertise) there is no expectation that the strategies employed are entirely self-regulatory. While we agree that enacting these cognitive strategies (whether surface or deep level) will probably be more successful when enacted alongside self-regulatory strategies, one can certainly employ a reading strategy without being self-regulatory. The degree to which this enaction with, without, or with limited self-regulation is more or less successful for different learners at different stages of expertise needs to be better fleshed out.

Discussion. With regard to the last point – that the link between levels of processing (and strategies more generally) and performance are not of tantamount importance – we disagree. Although we do agree that the ability to engage in self-regulatory strategies is important, this importance is limited if it does not lead to better performance or learning gains. For example, in studies of reading comprehension, there are readers who are termed *effortful* (Alexander, 2005; Dinsmore, Parkinson, Fox & Bilgili, 2019) who employ many strategies and do quite well in terms of performance outcomes. However, they are very inefficient – their reading times a quite a bit higher than readers in other categories, even those that were deemed to be *highly competent readers*. Thus, the relation between regulatory competence – which the *highly competent readers* possess – and reading outcomes is not so straightforward.

Fortunately, evidence supports that strategies – self-regulatory included – should improve performance for a wide range of tasks. Indeed, the MDL in particular proposes that metacognitive and self-regulatory strategies – along with a mix of surface-level and deep-level strategies – are necessary for performance in a domain except for someone who has advanced beyond the novice stage (i.e., in competence or expertise in the MDL). However, we also acknowledge that for some tasks, such as those that are routine or quite straightforward, the degree to which self-regulatory strategies are utilized or required are of much lower import.

Additionally, as a result of these reviews, empirical work that we have conducted, and our practical experience in classrooms with children, adolescents, and adults, we are skeptical of the more targeted view of *Hattie and Donoghue (2016) and *Vermunt and Donche (2017). In the previously mentioned reviews, contextual and individual factors play a key role. We certainly agree with Hattie and Donoghue that some strategies are better than others, but we would posit that the degree to which these strategies are better or worse is far more conditional than they state in their meta-analysis. We dissect this issue now as we turn to the contextual and individual factors that might mediate or moderate the relation between levels of strategy use and performance.

Influences of Contextual and Individuals Factors that Mediate or Moderate the Relation between Levels of Processing and Performance

The last of our three guiding questions examines how each of the reviews in the pool did or did not examine individual and contextual factors during strategy use.

Individual Factors. Eleven of the reviews in the pool specifically discussed individual factors that might influence the relation between level of processing and performance. The largest category of individual differences discussed across these reviews was motivation. Six of these reviews discussed some facet or multiple facets of motivation. For example, *Vermunt & Donche (2017) discussed goal orientations, attributions, effort, and self-efficacy, while Pintrich (1999) discussed self-efficacy, task value, and goal orientation. In general, across both of these reviews, autonomous motivation and positive conceptions of learning (e.g., higher self-efficacy) are more likely to lead to deeper-level strategies employed.

The next largest category was the discussion of prior knowledge or prior performance. Four reviews specifically addressed the importance of prior knowledge on the use of strategies: *Alexander and Judy (1988), *Alexander et al. (1998), *Dinsmore et al. (2018), and Paris et al. (1983). *Asikainen and Gijbels (2017), *Paris (1988), and *Vermunt and Donche (2017) discussed the role of prior performance – or patterns of performance in the case of Asikainen and Gijbels – in the use of strategies and how that influenced performance. As indicated previously, all these reviews support the notion that higher levels of prior knowledge lead to better deep-level processing.

The next set of factors that were mentioned in a few reviews were of epistemic beliefs and emotions. Two studies, *Alexander Grossnickle, Dumas, and Hattan (2018) and *Vermunt and Donche (2017), both discussed how more sophisticated epistemic beliefs might lead to advantageous differences in strategic processing – particularly the use of deeper-level strategies. *Hattie and Donoghue (2016) focused on a related construct, understanding criteria for success in their review. Finally, *Alexander et al. (2018) discussed learner emotions, while *Vermunt and Donche (2017) also addressed personality, age, and gender in his discussion. For Alexander et al. regulation of learner emotions was considered to be beneficial for strategy use, while for Vermunt and Donche they found that the personality factors of openness and conscientiousness were related to patterns of learning they describe as *deep* or *analytic*.

Contextual Factors. The scope of the reviews with regard to contextual factors was also wide ranging. Some of the reviews focused on specific domains such as reading (*Afflerbach et al., 2008; Paris et al., 1983), mathematics (*Ashcraft, 1990), and business (*Najmaei & Sadeghinejad, 2016). Other reviews, however, focused on how domain-general versus domain-specific investigations of strategic processing influenced performance (*Dinsmore, 2017; *Dinsmore & Alexander, 2012; *Dinsmore et al., 2018; *Vermunt & Donche, 2017). Overall, there seems to be consensus among these reviews that while there are some strategies that can be considered domain general, there is certainly quite a bit of evidence to suggest that being conscious of domain when examining strategic processing is important (e.g., Deekens et al., 2018).

Other reviews focused more on the setting in which these investigations of levels of processing took place. For example, *Asikainen and Gijbels (2017) focused solely on students enrolled in higher education, while *Alexander et al. (2018) addressed strategies that students might employ in online versus face-to-face courses. *Alexander et al. (1998) and *Vermunt and Donche (2017) addressed the role of conducive learning environments regarding levels of processing, which is a major area of research in its own right (cf. Gijbels & Loyens, 2008).

Discussion. For us, the discussion in these reviews of the individual and contextual factors that influence the levels of strategic processing and its relation to performance provide additional evidence that a less sophisticated model that posits more deep processing will lead to better performance should indeed be a historical notion. The degree to which there are interrelated constructs such as motivation and epistemic beliefs underscore the interconnected relations between levels of strategic processing and performance. Although many of the individual difference factors have been extensively systematically reviewed, the degree to which contextual factors have been reviewed in this regard is much less extensive.

FUTURE DIRECTIONS

Now that we have addressed the historical and current state of the field, we turn our attention to the future. Although research on levels of processing has spanned nearly a half-century since the work of Marton and Säljö, some progress has been made to create more sophisticated models and frameworks of levels of processing. However, we believe that we have much further to go. We now offer our suggestions for future research and implications for practice.

Future Directions for Research

First, as is evident from these reviews, there has been very little cross-theoretical work in the area of levels of processing. SAL has remained primarily a European and Asian framework, while SRL and the MDL have been primarily used in North America. The SAL tradition, which focuses on the role of the environment on levels of processing, has failed to meaningfully incorporate individual difference factors as well as specific task-level variables in its research agenda. Conversely, both SRL frameworks and the MDL have not taken the role of the learning environment appropriately into account. Some fusion of these primarily endogenous and primarily exogenous approaches to researching levels of processing is needed. As this research continues, it will be vital to continue to refine and adjust our definitions of surface-level and deep-level processing to address the challenges of modeling both individual and contextual factors of depth of processing on performance.

Second, it is also evident that new measures and measurement techniques will be required to propel the field forward. Fortunately, while there is still a long way to go, efforts are already underway to work collaboratively to solve these issues. One such effort is the scientific research network, *Learning Strategies in Social and Informal Learning Contexts*, which has a major focus on measures and measurements that expand our repertoire of tools including eye tracking (Catrysse et al., 2018), heart rate (Sobocinski, Malmberg, Järvelä, & Järvenoja, 2018), and neurobiological tools such as functional near-infrared spectroscopy (Dinsmore, Fox, Parkinson, & Bilgili, 2019). Although these are exciting approaches, it remains to be seen how the plethora of data generated can be effectively analyzed – or, as we will discuss subsequently, how these data may be useful to practitioners. The reader is directed to latter chapters of this Handbook for suggestions on how this might occur (Cho, Woodward, & Afflerbach, this volume; Freed, Greene, & Plumley, this volume; Fryer & Shum, this volume).

Implications for Practice

Past research – and these reviews in particular – offer less guidance on future implications for practice. A notable exception to this trend is offered by *Afflerbach's (2008) review. While not specifically geared toward levels of processing, the review article that was written for reading practitioners (e.g., teachers) would offer a blueprint for discussing the role of levels of strategies for teachers across disciplines. For instance, providing a detailed conception of how different strategies within science (Lombardi & Bailey, this volume) could be considered at the levels of strategies discussed here would provide a service to the field. There are few materials available for practitioners that specifically discuss the issues of levels of strategy use, with a few exceptions (e.g., *Dinsmore et al., 2018).

The bigger issue, however, is providing teachers with tools to measure students' levels of processing in any systematic way or on a more mass scale. The time and labor-intensive processes to collect, transcribe, and code think-aloud protocols are not realistic for teachers; neither are the data-intensive processes to analyze the myriad of strategies used by students on a daily basis approachable for teachers. Again, although we have far to go in this regard, there are potential solutions available in related areas of research.

In two ways, technology can be a helpful asset here. First, technology can be helpful in collecting these data. A good example of this trend is Fryer's application to measure interest (Fryer & Nakao, 2018). The application uses QR codes to scan and record interest levels in participants for certain tasks and activities. This idea has the potential to be exploited for use to measure levels of processing as well. Rather than rely on verbal transcriptions, students could be trained to use an application to concurrently report their strategy use and the levels of that use. Second, some system would be needed to help teachers analyze that data. In many areas of research a promising avenue to solving this problem is with machine learning (Pereira, Mitchell, & Botvinick, 2009). Machine learning uses the powerful computer processing and artificial intelligence to try to analyze patterns in data that humans cannot. However, we certainly have a long way to go with regard to designing and testing systems to analyze students' levels of processing.

Concluding Thoughts

We believe this is an exciting time to be engaged on research dealing with levels of strategy use. The reviews contained in this chapter point to many promising avenues of research that can enable us to better understand how these levels of processing are influenced by individual and contextual differences, how those differences might mediate and moderate the relation between levels of processing and performance, and finally, how those levels of processing might directly relate to performance. We hope this review is helpful to those already engaged in the field, but particularly to those new to this area of research.

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