EDUCATIONAL PSYCHOLOGY HANDBOOK SERIES

HANDBOOK OF STRATEGIES AND STRATEGIC PROCESSING

Edited by
DANIEL L. DINSMORE, LUKE K. FRYER,
and MEGHAN M. PARKINSON

ROUTLEDGE

Handbook of Strategies and Strategic Processing

Handbook of Strategies and Strategic Processing provides a state-of-the-art synthesis of conceptual, measurement, and analytical issues regarding learning strategies and strategic processing. Contributions by educational psychology experts present the clearest-yet definition of this essential and quickly evolving component of numerous theoretical frameworks that operate across academic domains. This volume addresses the most current research and theory on the nature of strategies and performance, mechanisms for unearthing individuals' strategic behaviors, and both long-established and emerging techniques for data analysis and interpretation.

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Routledge
Taylor & Francis Group
NEW YORK AND LONDON

First published 2020
by Routledge
52 Vanderbilt Avenue, New York, NY 10017

and by Routledge
2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

Routledge is an imprint of the Taylor & Francis Group, an informa business

Library of Congress Cataloging-in-Publication Data
A catalog record for this title has been requested

ISBN: 978-1-138-38993-9 (hbk)
ISBN: 978-1-138-38994-6 (pbk)
ISBN: 978-0-429-42363-5 (ebk)

Typeset in Minion Pro
by Swales & Willis, Exeter, Devon, UK

Dedications

To our children, Coraline and Louisa, who are the light of our lives – *D.L.D.* and *M.M.P.*
To Kaori Nakao for holding down the fort – *L.K.F.*

CONTENTS

1

INTRODUCTION

What Are Strategies?

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INTRODUCTION: WHAT ARE STRATEGIES?

The purpose of this introductory chapter of the Handbook is two-fold. First, we as co-editors want to lay out the case for the importance of the Handbook. Second, we want this chapter to serve as a guide for the reader to more deeply understand the need for continuing high-quality research on strategies and strategy use.

WHY A HANDBOOK ON STRATEGIES AND STRATEGIC PROCESSING?

Research on strategies and strategic processing has been steadily expanding over the last few decades. This expansion includes increases in the numbers of studies that examine cognitive strategies (Dinsmore, 2017), levels of strategic processing (Asikainen & Gijbels, 2017; Dinsmore & Alexander, 2012), and strategies associated with self-regulation (Dinsmore, Alexander, & Loughlin, 2008; Schunk & Greene, 2017). As many of these cited sources have indicated, the proliferation of this research has far from clarified the relation between strategies, strategy use, and performance. In fact, the past few decades have been marked with numerous calls to clarify these relations in numerous contexts and settings (Block, 2009; Dinsmore & Fryer, 2018) that include higher education (Fryer & Gijbels, 2017).

Two particular issues with regard to research on the influence of strategies and strategic processing on task and problem-solving performance have emerged that this Handbook is well positioned to address: how strategies and strategy use have been conceptually considered (across domains and contexts as well as levels of processing), and how they have been operationalized and analyzed. We will now turn to how this Handbook addresses each of these two challenging issues as well as additional contributions from the authors of these chapters.

CONCEPTUALIZATIONS OF STRATEGIES AND STRATEGY USE

The editorial decision to position the conceptualizations of strategies and strategy use early in this Handbook underscores the primacy of the issue of poor or misspecified conceptualizations of strategy use in the literature. First, numerous contributions in the first section of this Handbook – *Definitions, Forms, and Levels of Strategies* – explore conceptually and theoretically how strategies and strategic processing have been defined. Dumas (Chapter 2) explores the relations between strategies and their relations to the domains in which they are useful. He provides an overview of how the field has attempted to understand whether or not a strategy is domain general (i.e., useful across a wide number of domains) or domain specific (i.e., useful in one or a limited number of domains). Similarly, Dinsmore and Hattan (Chapter 3) explore how strategies have been stratified with regard to their purpose, or purported purpose – surface-level processing, deep-level processing, or metacognitive processing. Further, Rogiers, Merchie, De Smedt, De Backer, and Van Keer (Chapter 4) overview and offer a new framework to conceptualize strategy use over the lifespan. Finally, Butler and Schnellert (Chapter 5) explore the degree to which a strategy is an individual endeavor, or whether (and how) these strategies and utilization of these strategies may be socially shared across individuals performing a task or solving a problem. Research on strategies and strategic processing must be grounded in terms of how the learner is using them and what the learner is getting out of using them, which in our view is dictated by many factors, chief among them the development of many other cognitive and motivational factors.

Despite the fact that there is a section dedicated to conceptualizations of strategy use, we encourage the reader to consider this issue as they read the remaining three sections of the Handbook. In many cases, the theoretical frameworks from which these expert authors write color how strategies and strategic processing are conceptualized. For some, strategies are subsumed by or heavily influenced by self-regulation (e.g., Baars, Wijnia, de Bruin, & Pass, Chapter 14; Butler & Schnellert, Chapter 5; Winne, Chapter 15). While we as editors do not share this view that strategies should be subsumed in this way, the influence of self-regulation and self-regulated learning on the research regarding strategies and strategy use is undeniable. We strongly encourage readers – especially those new to the field – to keep in mind that the conceptual lines between metacognition, self-regulation, and self-regulated learning themselves have been conceptually muddy for quite some time (Dinsmore et al., 2008) and the role that strategies play within and beyond these three constructs has been even murkier. Additionally, we note that the distinction between *strategies* and *skills* is often blurred. This distinction is made in numerous chapters throughout (Afflerbach, Hurt, & Cho, Chapter 7; Alexander, Chapter 25; Dinsmore & Hattan, Chapter 3; Dumas, Chapter 2) – an issue of great import since Alexander and Judy's (1988) review article. We hope the chapters in the first section provide the reader with a solid foundation to consider these two issues as they attempt to synthesize these chapters for themselves. Fortunately, the reader is further aided in this synthesis through Van Meter and Campbell's (Chapter 6) illuminating commentary. As we have attempted in this introduction as well, Van Meter and Campbell expertly lay out the case for why strategies should garner special consideration in the literature, in particular given the connections between strategies and problem-solving and task outcomes.

CONCEPTUALIZATIONS OF STRATEGIES IN THE CONTEXT OF INSTRUCTION

Many of the issues alluded to in the previous section may be dependent on the context in which strategies are employed. These issues refer to both the domain and social setting within which strategies and strategy use are considered. The second section – *Strategies in Action* – explores how domain or social setting may change the role of strategies within the broader framework of learning. Strategies and strategy use are considered in the five major academic domains – reading, writing, mathematics, science, and history.

First, Afflerbach et al. (Chapter 7) consider the nature of how strategies and strategic processing both influence the reading situation, as well as how optimal reading strategies can be instructed. Similarly, Graham et al. (Chapter 9) consider domain-specific strategies in writing and how these can be trained. Both of these chapters embed notions of strategy use and their training in contemporary models of reading comprehension (e.g., Kintsch, 2004) and writing (e.g., Graham & Harris, 2006). An important addition to the research on strategy use while reading and writing is undertaken by List (Chapter 8) in her exploration of strategies around multiple text use. The need to employ specific strategies to navigate multiple sources of information is becoming particularly salient with the explosion of information that is prevalent in the age of the Internet and social media. This is especially true as that multitude of information contains conflicting views that the reader must navigate.

Similar explorations of mathematics and science are undertaken by Newton (Chapter 10) and Lombardi and Bailey (Chapter 11) respectively. Given the incredibly broad depth of the field of mathematics, Newton focuses primarily on strategies used to solve algebraic problems and fraction problems – two critical gatekeepers for future mathematical inquiry. Although her chapter focuses on these two areas, we are confident the implications of the chapter could be applied to numerous other areas of mathematical inquiry (e.g., trigonometry) and hopefully give the reader a framework to explore these other areas on their own. Similar to mathematics, the broad range of strategies required across the numerous physical, life, and social science domains are difficult to manage in one chapter. Lombardi and Bailey handle this well by focusing on recent strategies that are common across these sometimes disparate fields – namely, argumentation, science as modeling, and the incorporation of socio-scientific topics to promote strategy use. In the current climate where science is under attack by certain political forces, this chapter provides clear direction with regard to helping the populace use these strategies to better advance science as well as our overall way of life.

While the preceding domains have a richer history of strategies and strategy instruction, De La Paz and Nokes (Chapter 12) tackle strategies in the domain of history. These authors discuss the intertwined nature of historical inquiry with both the domains of reading and writing. However, as they astutely point out, historians must possess particular strategies that enable them to engage in historical thinking that reaches beyond just those who read and write text. For instance, being able to generate interpretations and knowledge claims are considered a central strategy for historians to have at their disposal.

Next in this section is a primer for understanding how learners' individual differences may influence their strategy use and ultimately their learning outcomes. Taboada Barber, Lutz Klauda, and Cartwright (Chapter 13) explore how language proficiency and atypical reading development (i.e., students with reading comprehension deficits) may influence strategy use. Their key argument is to examine these issues in relation to executive function (i.e., working memory, inhibition, and cognitive flexibility). While they situate this exploration primarily within the domain of reading, we believe this framework could be used equally well to explore strategy use and individual differences across multiple domains and contexts.

However, task completion and problem solving are not always so easily broken down into a single domain or context. Baars, Wijnia, de Bruin, and Pass (Chapter 14) discuss how working across individuals in social settings as well as across domain barriers can be best conceptualized and facilitated. Using an SRL framework, these authors provide the reader with strategies – at the cognitive, metacognitive, and self-regulatory levels – to cope with complex, dynamic problems.

Winne (Chapter 15) takes on the difficult task of trying to synthesize strategy use and training across these multitudes of domains, contexts, and individual differences. Winne provides a framework – situated within self-regulated learning – to tie together these otherwise disparate chapters. This insightful synthesis will no doubt go far in helping the reader construct for themselves a more global view of strategies and strategy use, whether or not that view is more heavily oriented toward SRL, as Winne would argue, or less so, as the editors here would argue for.

OPERATIONALIZATIONS AND ANALYSIS OF STRATEGIES AND STRATEGY USE

While the first two parts of the Handbook explore conceptual and contextual issues of strategies and strategy use, clarifying conceptions is far from the only issue in the contemporary strategies literature. As we hope this Handbook can help lead to some consensus on what strategies are, we are equally concerned with how strategies have been operationalized in the literature. This issue has encompassed both cognitive strategies themselves (e.g., Dinsmore, 2017) as well as metacognitive strategies (e.g., Veenman, Van Hout-Wolters, & Afflerbach, 2006).

The third section – *Measuring Strategic Processing* – begins with the most ubiquitous measurement of strategies and strategic processing (Asikainen & Gijbels, 2017; Dinsmore, 2017; Dinsmore et al., 2008). In this chapter Vermunt (Chapter 16) captures both the historical role of surveys and retrospective self-report as well as the fraught relationship researchers have had with these measures over the past few decades.

While critical of the shortcomings of self-report, Vermunt also offers suggestions for how retrospective self-report and surveys can continue to contribute to the literature. In addition to the arguments in the literature around retrospective self-report, concurrent self-reports have also endured some criticism as well. Bråten, Magliano, and Salmerón (Chapter 17) mirror Vermunt's concerns in discussing both the shortcomings of concurrent self-report, in addition to their future as viable measures of strategies and strategic processing going forward.

These more established measures are recently being challenged by two new paradigms: the emergence of Big Data and the use of physiological measurements of strategic processing. Lawless and Riel (Chapter 18) explore how Big Data is becoming more and more ubiquitous in examining strategies – primarily consumer strategies – in the corporate setting. Behemoth companies like Google employ complex algorithms to examine this strategic behavior (or lack thereof) across Internet search platforms as well as social media platforms. On the one hand, the amount of data is enticing; however, as Lawless and Riel point out, this avalanche of data and the secrecy with which the algorithms are used to examine this data are troubling. In addition to the arrival of Big Data on the scene, the use of physiological measures continues to increase year by year. Catrysse, Gijbels, and Donche (Chapter 19) overview two of these measurements – eye tracking and functional magnetic resonance imaging (fMRI). As with the Big Data chapter, they expose the reader to the promises of these new technologies to better understand strategies and strategic processing, while at the same time critically examining the gaps and difficulties these new approaches represent.

Gijbels and Loyens (Chapter 20) in their commentary weigh the pros and cons of these approaches and offer readers a way to think about designing experiments that leverage the strengths of these particular measurements to best answer their research questions. We certainly agree with Gijbels and Loyens that no one measurement will provide a panacea to investigating strategies and strategic processing. Rather, it will be necessary to smartly employ some combination of these techniques to better help learners become strategic.

The final section – *Analyzing Strategic Processing* – examines the multitude of ways that strategic processing has been examined. Of particular import here is that, similar to the measurement of strategic processing, the analysis or analyses has to first and foremost serve the purpose of the research questions as well as help us better build theories relevant to strategic processing. The Handbook offers three such chapters to help the reader ponder appropriate analytic strategies. The first of these, quantitative variable-centered approaches, are probably most familiar to our readers. Freed, Greene, and Plumley (Chapter 21) not only overview these familiar approaches but also help situate these approaches in the context of analyzing strategic processing, something that not every reader will necessarily have considered. The other quantitative approach – the person-centered approach – is discussed at length by Fryer and Shum (Chapter 22). They offer exciting new ways to analyze strategic processing that have been used primarily in the motivation literature thus far. Finally, with regard to analyses, Cho, Woodward, and Afflerbach (Chapter 23) offer approaches to qualitative examinations of strategic processing. Situated mostly in the context of strategic processing during reading, this chapter provides a framework for qualitative analysis that could certainly be applied in a multitude of contexts.

Of course, being able to select the appropriate analysis is most crucial to effectively analyzing strategic processing. While this is often a difficult endeavor, the reader is aided by Cromley's (Chapter 24) synthesis of these analytic approaches. She deftly describes the pros and cons of these approaches which will undoubtedly aid the reader in selecting an appropriate analysis or analyses.

THE FUTURE OF RESEARCH ON STRATEGIES AND STRATEGIC PROCESSING

While our hope is that this Handbook will help researchers in the field, both experienced and new, to understand the history of strategies in the literature as well as state-of-the-art conceptualizations and methods, we also hope these chapters and commentaries will inspire researchers to challenge existing paradigms, refine and possibly replace theoretical frameworks, and trailblaze new methods to uncover how strategies can help learners overcome challenges and solve the complex, dynamic problems that we face in the 21st century. To help readers synthesize across the four sections of the Handbook, Alexander (Chapter 25) has provided a unique and insightful overview of this history, contemporary research, and a vision for future research that can enable us to employ the vast knowledge that we possess about strategies and strategy use to help learners young and old alike.

This Handbook is a unique collaboration of contributions from researchers across a wide array of theoretical frameworks and disciplinary perspectives. We are indeed fortunate as editors that these authors have shared their wisdom and insights and we hope you agree that they have made this Handbook an informative and inspiring guide for the future.

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Section I

Definitions, Forms, and Levels of Strategies

2

STRATEGIC PROCESSING WITHIN AND ACROSS DOMAINS OF LEARNING

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INTRODUCTION

Educational psychologists observe various aspects of learning and education—whether it be large-scale educational data collected across many schools (e.g., Cameron, Grimm, Steele, Castro-Schilo, & Grissmer, 2015), or more finely grained data collected in a laboratory setting (e.g., Xie, Mayer, Wang, & Zhou, 2019)—and pose a fundamental question: *why do students differ so substantially in their academic outcomes?* (Alexander, 2018). Since the 1890s (James, 1890; Mayer, 2018), educational psychologists have identified and investigated many explanatory factors for the observed student variance in learning outcomes, including but not limited to: intelligence and other cognitive functions (Canivez, Watkins, Marley, Good, & James, 2017), motivation and goals (Linnenbrink-Garcia et al., 2018), self-regulatory abilities (Winne, 2018), and socio-emotional support and development (Wentzel, Muenks, McNeish, & Russell, 2018).

This body of educationally relevant psychological constructs can generally account for hundreds of published educational psychology research studies, but, beginning in the latter part of the 1980s (Alexander & Judy, 1988; Pressley, 1986), educational psychologists began to understand that none of these constructs is the most proximal influence on student performance in school. Instead, the actual procedures that students enact while learning—the specific cognitive actions that students engage in during the learning process—are a much more readily useful predictor of student learning outcomes than are student's pre-existing individual differences or abilities (Alexander, Graham, & Harris, 1998; Dinsmore, 2017). Here, these cognitive procedures are referred to as the *strategies* or *skills* that students employ in order to solve a problem, independently study from text, or regulate their academic activities.

After the identification of strategic or skillful processing as the most proximal influence on student achievement in schools, a number of further patterns emerged in educational psychology data that have complicated this picture. For instance, it had long been understood (e.g., Thorndike, 1913) that student variance existed not only inter-individually in educational outcomes but also intra-individually, meaning that an individual student may be more or less effective at problem solving, studying, or learning in a particular domain of knowledge (e.g., mathematics) than they are in another domain (e.g., reading). But, explaining these intra-individual differences in terms of procedural strategy differences within a student offered some conundrums. For example, some strategic processes used for learning (e.g., self-questioning; King, 1989) appeared to be effective at supporting educational outcomes across a variety of domains, while others were more specific to a single domain (e.g., counting-all in early mathematics; Baroody, 1987). As such, students who more readily use domain-general strategies, or cognitive procedures that are useful across a variety of domains of learning, may have stronger outcomes across a range of academic domains, while those who struggle to use domain-general strategies may have more pronounced intra-individual differences in their learning outcomes across domains because they rely more on strategic processes that are *domain-specific*, or are only useful in one particular domain of learning.

However, even for those strategies that have been identified as *domain-general*, some students are more capable of flexibly utilizing these general procedures across different learning contexts than are other students (Campione & Brown, 1984; Cushen & Wiley, 2018), limiting the degree to which domain-general strategic processes are actually transferred across domains of learning in real-world educational settings. For this reason, being capable of utilizing a strategic process that is theoretically domain-general (e.g., outlining) within one particular domain (e.g., history) does not necessarily mean that a student will be effective at using the exact same strategy within another domain (e.g., biology). This highly limited degree of *strategy transfer* across domains of learning has complicated the degree to which the true domain-generality or domain-specificity of any given cognitive procedure can be identified by researchers. The observed uncommonness of strategic transfer also creates instructional difficulties in that, in some cases, it remains unclear whether the teaching of strategies specific to a given domain or more general strategic procedures is a more effective instructional choice. This is because domain-general strategies may appear to be more widely effective for students to learn, but without the capability of identifying wider learning contexts in which that strategy is useful, students may never actually transfer the strategy across domains. If this occurs more often than not, it may be more prudent for educators to focus on domain-specific strategies with the pre-supposition that strategy transfer will not occur anyway. In this chapter, issues such as this, that center on the degree to which cognitive procedures used for learning and problem solving can be considered transferable across domains of learning (i.e., domain-general), are reviewed and discussed.

CONCEPTUALIZING STRATEGIES IN EDUCATIONAL RESEARCH

The question of whether a given strategy can be considered domain-general or specific relies in critical ways on the definition and conceptualization of strategies themselves. Here, strategies are defined as goal-directed procedures that are planfully and effortfully used to aid in the regulation, execution, or evaluation of a particular problem or task (Alexander & Judy, 1988). In this way, strategies can be useful either within a single domain of learning or across many domains, but all strategies are essentially a special form of procedural knowledge in which a student knows how to enact a given process that improves their capability in problem solving or learning. For example, the study strategy of creating a concept map in order to organize and relate information is, in itself, a form of knowledge because a student has to know what a concept map is and how to create one effectively. But, the procedural knowledge of how to create a concept map can be identified as strategic because such procedural knowledge improves a student's development of the particular academic knowledge (e.g., the civil rights movement within the domain of history) that they are studying when the concept map is used. Of course, a concept map may also be hypothetically helpful when the same student is studying a different topic in a different domain (e.g., taxonomic categories in biology), but there is no guarantee that the same individual student will be capable of evoking the concept map strategy equally effectively across domains.

As stated above, a key component to the definition of strategies is that the procedures enacted by students are done so purposefully, effortfully, and consciously. In contrast, if a strategy is utilized by an individual student enough times that it becomes an automatic habit of mind, it is no longer utilized effortfully and therefore is not referred to as a strategy. Instead, an automated form of procedural knowledge that students may utilize to improve their learning or performance within and across academic settings is referred to as a skill (Afflerbach, Pearson, & Paris, 2008; Alexander et al., 1998). Using this terminology, skills and strategies are often referred to together within the literature (e.g., Vettori, Vezzani, Bigozzi, & Pinto, 2018) because direct instruction of these procedures must begin with the assumption that students will use strategies effortfully before progressing to more automated and rapid utilization of skills. In some areas of educational research that focus on domains or disciplines in which very rapid problem solving is highly valued and a typical instructional goal, e.g., medical education research, Dumas, Torre and Durning's (2018) strategies and skills may be referred to synonymously with the understanding that the fast and automatic deployment of cognitive procedures is the best or only way to utilize particular strategies in the real-world setting, e.g., triaging patients based on visible symptoms. In contrast, educational research that focuses on domains of learning or populations of students in which a slower, more effortful processing typically results in better student outcomes (e.g., multiple-source use; De La Paz & Felton, 2010), shows that the careful theoretical division of strategies and skills is more common within the literature.

One way in which the distinction between strategies and skills complicates the question of domain-generality that is the central focus of this chapter is that, within the same student, certain forms of procedural knowledge may be more or less effortful (i.e., strategic) or automated (i.e., skillful) across domains. In this way, even though a student is capable of using their procedural knowledge to learn more effectively across domains, the actual enactment of that procedural knowledge may appear very different and make domain-general strategic processing difficult to identify. For example, if a student has ample experience in reading informational or persuasive text, they are likely to be familiar with the strategy of questioning the author to improve their comprehension of the text. In fact, they may be so practiced at questioning the author that they do so automatically and rapidly (i.e., skillfully) when reading. However, if the same student visited the more unfamiliar context of an art museum and found themselves tasked with "reading" visual art (i.e., painting or sculpture), they may either not understand that the strategy of questioning the artist was useful, or they may transfer the procedural knowledge effectively, but do so in a slow, effortful (i.e., strategic) way. In this way, the procedure of questioning the author/artist would be a domain-general process, but the enactment of that procedure may appear so different in its pacing and effortfulness that an instructor who worked with the student across domains may not recognize the process as the same.

Such a scenario highlights a fundamental aspect of strategies in that they are something that students *do*. This specifically procedural aspect of strategies and skills separates this area of research from the majority of areas within psychology that focus on mental constructs that individuals *have*. In the educational psychology literature, it is not difficult to identify a number of research foci that are specifically defined as something that students have, or are working to develop, within their minds. For example, creativity is one construct that has historically concerned educational psychologists (Dumas, 2018; Torrance, 1972) and that is typically defined as something that students have in varying amounts and the development of which is supported to varying degrees by particular instruction. However, such a conceptualization of creativity, however interesting and relevant to education, cannot directly describe what students specifically do, in terms of cognitive processes, in order to produce more creative ideas. For that, a much more specific line of research inquiry on strategies for creativity would be needed. This foundational "have vs. do" issue in strategy research is highly relevant to the measurement of strategies (Liu, 2014), because the observation of a cognitive process that students do is much more difficult and specific an undertaking than the quantitative estimation of a cognitive ability that students have. This measurement-related issue will arise again within this chapter during the discussion of the operationalization of domain-generality and specificity, because psychometric procedures designed for the measurement of constructs that students have (e.g., factor analysis) make different predictions about the domain-generality of skills and strategies than does a more specific process-oriented approach. However, before this operationalization problem can be discussed, the meaning of a domain of learning in contrast to other defined areas such as discipline or task must be explained.

AREAS OF LEARNING: DISCIPLINES, DOMAINS, AND TASKS

In educational psychology, the work of the researcher is highly influenced by the general area of learning that is under investigation. For example, research about mathematical education would likely utilize completely different participants, measures, methods, and even theoretical frameworks than research on musical education. For this reason, the careful definition of the area of learning being studied is of critical importance in the literature, especially when questions of the generality or specifically of knowledge are being asked. Here, I review three ways to define an area of learning—by discipline, domain, or task—and highlight the ways in which those definitions may influence the way strategies and skills are understood in the research literature. While these terms are often used synonymously, I will attempt to show how a muddling of these definitions can result in incorrect inferences about the domain-generality of strategic processes.

Based on the root-word *disciple*, a *discipline* is an intellectual lineage or group of people who work in the same area, communicate knowledge to one another, and practice many of the same procedural skills in their work (e.g., Stoecker, 1993). In this way, not only are the forms of procedural knowledge (e.g., strategies and skills) held by a group part-and-parcel of their disciplinary definition, the conceptualization of a discipline as being fundamentally composed of *people* explains how all those individuals developed the same knowledge and practices in the first place: they learned them from their intellectual mentors or shared them with one another. So, a given individual can have an *interdisciplinary* background if they were trained in multiple disciplinary communities, or a given team can be interdisciplinary if members of that team are drawn from differing disciplinary communities.

Given this definition, I would contend that a focus within educational research on differing disciplinary practices lends itself most readily to a more socio-cultural theoretical understanding of learning, in which the communities that work together hold procedural knowledge and the teaching of students constitutes a socialization into a disciplinary community. For example, some researchers who use social network models to study scientists (e.g., Bozdogan & Akbilgic, 2013) take a disciplinary focus in that person-to-person collaborative connections define the borders of the disciplines, and those individuals who learned from the same mentor are assumed to have many attributes in common, especially procedural knowledge. In this way, it is possible for a strategy or skill to be discipline-specific not because it is only theoretically useful to a single group of people, but because it has not been communicated effectively or adopted across disciplinary lines for socio-cultural reasons. For example, the procedural strategy of using machine-learning models to understand open-ended textual data is commonly used within the discipline of the information sciences (Fan, Wallace, Rich, & Zhang, 2006), while it is almost never used in educational psychology. This is not because educational psychologists have no need to understand open-ended text-based data sources, but because machine-learning models have not historically been a part of our disciplinary training. As this example implies, a research focus on disciplinary differences or similarities can be difficult in educational psychology because the school-aged students who are often the focus of our research cannot really be described as members of a particular discipline in the way that those further along the path to expertise can be.

In contrast to a discipline, a domain is an area of *knowledge* that can be studied or taught and therefore developed or constructed through the learning process within an individual (e.g., Greene et al., 2015). So, while a discipline is a unit of intellectual community members, a domain is a unit used to designate the knowledge itself that was created within that discipline, or that is commonly utilized within that discipline, and that individuals operating within that discipline may be likely to hold. What this implies is that, while disciplines and domains are similar enough to potentially have the exact same name (e.g., terms like psychology or mathematics may be simultaneously disciplines or domains), the boundaries of each are based on different criteria. For example, within the discipline of educational psychology—which is defined by our shared intellectual heritage, our communication outlets, and inter-personal collaborations—many of our community members hold and utilize the same declarative and procedural knowledge that supports us as we do our work (i.e., knowledge within the domain of educational psychology). However, many educational psychologists also possess knowledge that is rooted and commonly utilized within a different domain (e.g., statistics). Therefore, we may say that the declarative and procedural knowledge that constitutes the domain of educational psychology overlaps in important ways with other domains of learning. This overlapping knowledge that is useful across multiple domains of learning can be identified as domain-general. If that knowledge that we draw upon is procedural and effortfully evoked, then that knowledge can be defined as strategic, and if a particular strategy is useful for the creation or dissemination of knowledge across multiple domains, it may be described as a domain-general strategy. So, a particular strategy (e.g., using a correlation matrix to understand the relations among variables) may be used to develop or transmit knowledge across a variety of domains (e.g., psychology, sociology, economics), marking it as a domain-general strategy. In this way, it can be seen that experts in a given domain evoke domain-general strategies in their day-to-day work.

One other important note concerning the distinction between disciplines and domains is that, when teaching occurs in schools, especially to younger or less expert students, the knowledge being taught is often separated from the disciplinary community in which it arose. Therefore, the development of domain knowledge, rather than disciplinary acculturation, is often more relevant to educational psychology research with school-aged students (e.g., Bong, 2005). For example, a middle-school student learning about photosynthesis cannot be described as truly joining the discipline of botanists, but instead can be described as learning domain-knowledge in botany. So, if a given cognitive procedure (e.g., note-taking) is effective at improving that student's learning about photosynthesis and is also effective at improving their learning in another domain (e.g., history), then that strategy is effective across domains, and is therefore domain-general. For this reason, that domains of knowledge are often more pertinent to educational psychology research questions than are disciplines of practice, the main focus of most extant research on learning strategies (Alexander, Murphy, Woods, Duhon, & Parker, 1997), as well as the focus of this chapter, is on domains, not disciplines.

Another, more fine-grained way to define an area of learning is through the specific *task* being accomplished by a student, rather than the discipline being participated in or the domain being learned. For example, an elementary-school student may be studying within the domain of geography, but the specific task on which they are working may be labeling a map of the United States with the names of the states and their capitals. Another task that this same student may work on within the same domain of geography may be identifying and defining different types of landforms (e.g., volcano, mesa, peninsula, etc.). Clearly, there would be some strategies that can be effectively used to improve this student's performance on both of these tasks. For example, connecting the new geographic information to their prior knowledge about North America may aid this student in learning related to both tasks, and self-testing may help them evaluate their learning across both tasks. In this way, both of these strategies are clearly generalizable across tasks within the domain of geography. If these strategies were to be helpful in the completion of tasks that arise in a different domain (which they hypothetically would be), they would be domain-general.

In contrast, some well-known strategies are highly specific to a single type of task within a particular domain of learning. For example, the commonly taught First-Outer-Inner-Last (FOIL) strategy for multiplying binomials is a task-specific, and therefore also domain-specific, strategy. Another mnemonic, the Every-Good-Boy-Does-Fine strategy for remembering the notes on a music staff is specific to a single type of task within the domain of music. Such strategies are examples of a more general type (i.e., the mnemonic), but their specific formulation makes them highly task-specific in their usefulness. Despite the very specific nature of these strategies, they are still commonly taught because they allow even novice students to quickly accomplish core tasks within a particular domain, and the successful automatization of such a strategy (i.e., becoming skillful) allows for more advanced learning in the domain. For example, although the Every-Good-Boy-Does-Fine strategy is a time-consuming and task-specific procedure, it may lead to the development of a skillful ability to read a music staff automatically, which in turn allows for further learning of music theory.

Because a strategy is defined as a form of procedural knowledge effortfully evoked for the accomplishment of a particular goal, I would contend that, in their actual real-time enactment, all strategic instances are necessarily task-specific. Students employ strategies to improve their performance on the task at hand, and therefore the specific procedural knowledge evoked must be effective and useful for a particular task in order to be considered strategic. Then, if that task bears enough similarity to other tasks across the domain of the learning, a particular strategy becomes task-general, but may remain domain-specific. Only if the tasks required across domains have enough structural features in common will a particular strategy be effective across those domains and rise to the level of domain-generality. For example, because both the domains of biology and history feature large amounts of novel information that students are expected to memorize and integrate, the tasks students must accomplish across these two domains of learning within schools are at times highly similar. For this reason, the strategy of *outlining* is useful when learning across the domains of biology and history, marking it as a domain-general learning strategy.

Going forward, these definitions of discipline, domain, and task will be used to carefully delineate findings related to the generality and specificity of particular cognitive procedures used for learning and problem solving. In the following section, I turn to a further question: what evidence do researchers use to determine whether a particular strategy is domain-general or domain-specific, and how do those methodological differences influence the conclusions drawn about the generality of particular strategies?

OPERATIONALIZATION OF GENERALITY AND SPECIFICITY

Within the existing research on domain-general and domain-specific strategic processing, an initial operational divide exists between those who identify particular strategic processes as domain-general mainly theoretically based on a conceptualized usefulness of a given strategy across domains (e.g., Niaz, 1994), and those that rely on data (possibly published across multiple studies) to determine if a particular strategy is actually domain-general in its usefulness (e.g., Dinsmore, 2017). One reason why this pattern may be problematic for this area of research is because some sets of strategies can be described as domain general (e.g., help-seeking strategies) because, theoretically, such a type of strategy can easily be conceptualized as useful across a number of tasks and domains of learning. However, in the actual enactment of a strategy such as help-seeking across domains, tasks, learning contexts, or developmental periods, such a strategy may appear very divergently. For this reason, theorizing about the domain- or task-generality of particular strategic processes can sometimes rest upon implicit semantic and ontological categories within the mind of the researcher, making theoretical debates about domain-generality or specificity of a given strategy difficult to resolve (hypertext reading strategies is one recent example of this; Alexander, Grossnickle, Dumas, & Hattan, 2018; Leu et al., 2008).

Help-seeking strategies, and their various specific enactments across contexts, can form a useful illustration of the way in which theorizing about the domain-generality of strategic processes can depend on the ontological categorization of those processes. For example, a young child learning to draw with colored pencils may evoke a highly emotionally charged help-seeking strategy (e.g., crying) while a graduate student learning to do statistical analysis may employ a very different help-seeking strategy, such as reading statistical message boards on the Internet. Are these two very different sets of behaviors both instances of the same strategic process? Because strategies have historically been defined as *goal-oriented* and effortfully used procedural knowledge (Alexander & Judy, 1988), and therefore must be in service of accomplishing a goal, the goal itself (e.g., getting help) may not be the most useful way to define or identify the strategy. Rather, it may be more helpful to theoretically separate a student's goal in enacting a strategy from the strategy itself, as some in the literature have previously done (e.g., Fryer, Ginns, & Walker, 2014). This is because, many human goals are necessarily salient across domains of learning, and a variety of different strategic processes may be useful in achieving those goals (Ames & Archer, 1988). This conceptual issue is relevant to the main focus of this chapter, because the goal of a strategy may be inherently domain-general, but the particular process that an individual student uses to achieve that goal (i.e., the strategy) can be domain-specific in its enactment.

Complicating matters further, it is of course always possible for a student to *attempt* a particular strategy on a task or within a domain or discipline in which it is not appropriate. But does the presence of an attempt indicate the strategy is domain-general? I would argue that some commonly expected effectiveness should be required to mark a particular strategy as domain-general, rather than simply an attempt. To return to the help-seeking example above, the young-child that resorted to crying as a help-seeking strategy while learning to draw with colored pencils may find the same strategy is not effective on another task or within another domain (e.g., learning to play a video game), because care-givers or instructors may respond differently across those contexts. The difference in effectiveness of this particular help-seeking strategy may be even more stark across developmental periods as the child grows up. As a somewhat frivolous example, crying is not likely to be a highly effective help-seeking strategy in graduate level statistics courses, but other forms of help-seeking such as sending an email to an instructor may be effective. In all of these cases, the goal of the procedure is the same (i.e., help-seeking), but the actual process engaged in by the learner is very different both in its enactment and in its effectiveness (Reeves & Sperling, 2015).

The issue of disentangling the strategic process from its goal is related to the further methodological problem of meaningfully connecting the observed behaviors of participants to their underlying cognitive mechanisms or latent structure. For instance, one of the most frequently utilized methods for making inferences about underlying mental attributes from observed data is through latent variable analyses such as factor analysis or item-response theory models (e.g., Dumas & Alexander, 2016). Such models relate to the study of domain-generality and specificity, because they are capable of using the covariance among observed variables to determine whether an observed variable (e.g., an item on a measure) indicates a highly specific latent attribute or a latent attribute that is more generalizable. The well-known and influential theory of general intelligence (*g*; Spearman, 1904) is one theoretical perspective that posits a body of entirely domain-general cognitive abilities that is based mainly on evidence from factor analytic investigations. In contrast, other theories about the structure of mental attributes include more domain-specific cognitive attributes (e.g., Carroll, 1993), and also base their arguments on factor analytic evidence. Within this factor analytic tradition, the way in which student performance on particular tasks covaries is used to make inferences about the generality of underlying abilities. For example, if student performance on a number of tasks or measures covaries strongly and in a positive direction, an inference can be made that a generalizable underlying latent attribute causes the variation in performance on each task. In contrast, if performance on a number of tasks covaries weakly, the opposite inference—that multiple highly specific latent attributes are present—can be made.

However, one major weakness in linking latent variable research to research on strategic processing is that the actual cognitive processes required for the successful completion of the type of tasks or tests that are conducive to psychometric analysis are seldom known authoritatively enough to infer that the procedural knowledge being measured is actually domain-general or if some other capacity such as processing-speed (Habeck et al., 2015) is driving the covariance. In addition, almost any cognitive task over a certain level of complexity can be solved in multiple ways and using varying strategic processes, so the covariance structure of performance data that is typically used in factor analytic research can rarely point directly to specifically identified strategic processes. In this way, latent variable methods are highly useful for identifying the domain-generality of *abilities*—that consist of both declarative and procedural knowledge evoked in both quantitative and qualitatively different ways across students—but struggle to provide strong evidence for the domain-generality of strategic processes themselves. Please see Greene and colleagues' contribution to this Handbook for a full discussion of variable-centered methodological approaches to strategic processing research.

In contrast to methods that use the covariance among task performance to infer the generality of cognitive functions, other programs of research that have been relevant to the domain-generality and specificity of cognitive strategies have used a process-oriented methodological and measurement approach. In such an approach, the actual processes that participants enact while problem solving are the focus of research. For example, studies in this tradition may utilize think-aloud (Anmarkrud, Bråten, & Strømsø, 2014) or eye-tracking (Catrysse et al., 2018) methods in order to identify not only whether or how well students are able to complete a task but also how they go about it procedurally. Using data such as these, researchers are able to determine whether or not a particular strategy is useful to students across multiple learning tasks, domains of learning, or even across multiple disciplines of practice. For example, if researchers observe students engaging in the same or very similar strategic procedures (e.g., summarizing text) both when they are learning biology and when they are learning psychology, that may indicate that such a strategy is domain-general because it is used across domains.

Of course, the same strategy may be differentially effective across domains and may constitute a highly adaptive or optimal strategy in one domain while it is a relatively weak strategic option in another domain. For example, visualizing may be a highly useful strategy in such domains as chemistry or geometry, but only a somewhat useful strategy within domains such as history. Nonetheless, students may engage in the visualization strategy across both domains, marking it as a domain-general strategy. Such a pattern illustrates a critical point for the direct instruction of strategic processes to students. While an instructor may teach domain-general strategic processes and describe them as such to students, it is likely also critical to carefully explain the particular tasks or learning contexts within those domains for which the strategy may be most appropriate. One example of a strategy that may be over-used, at least by undergraduate students, is highlighting (Cerdán & Vidal-Abarca, 2008). As a support for organizing and remembering what is read, highlighting appears useful across many different types of texts and reading situated in a variety of domains. But, more detailed research has shown that highlighting typically supports only surface-level cognitive processing and can be much more or less effective depending on the elements of the text being read and highlighted (e.g., whether or not the text features technical diagrams; Cromley, Snyder-Hogan, & Luciw-Dubas, 2010). For that reason, a strategy like highlighting may be domain-general, but its effectiveness for learning across domains is far from definite.

In addition, the identification and operationalization of the domain-generality of a given strategy is complicated by the question of whether or not domain-generality presupposes that the same strategy is useful across domains by the same individual student, or whether domain-generality can mean only that the strategy is useful across domains, but not by the same student. This question deals specifically with the relations among strategies and the way ability or performance in a given domain is typically measured, as well as the question of transfer of procedural knowledge across tasks and domains.

GENERALITY AND SPECIFICITY WITHIN AND ACROSS INDIVIDUAL STUDENTS

The focus of this chapter is on the enactment of strategic processes both within and across domains of learning, wherein a strategy that is utilized across multiple domains can be described as domain-general, but a strategy that is only utilized within a single domain can be described as domain-specific. However, such a designation begs a follow-up question: are domain-general strategies utilized across domains *by the same individual student* or are they merely utilized across domains, but by different individual learners? Further, are there individual differences across students in the readiness with which they transfer strategic knowledge to new tasks or domains?

As an example of this general query, take a strategic process that is typically considered to be domain-general, such as connecting to prior knowledge. Theoretically, such a strategy must be considered domain-general because it is easy to imagine that, regardless of the academic situation, new information being presented to a student may be related in some meaningful way to something that the student already knows. Indeed, researchers who have studied students learning across a variety of domains (e.g., Afflerbach, 1990) have observed that connections to prior knowledge can and do arise across domains. However, it is also relevant to consider that, within the same student, certain domains of learning may appear more salient or relevant to their past experiences for a variety of socio-emotional or identity-based reasons (e.g., Hartwell & Kaplan, 2018). Students may be differentially cognitively effective at mapping new information onto their prior knowledge across domains where the relations between prior knowledge and current instruction are not made explicit (Richland & McDonough, 2010), or they may simply possess differential amounts of prior knowledge across domains, limiting the possibility of them connecting new information to that prior knowledge. Therefore, even a highly domain-general strategy such as connecting to prior knowledge can be variant in its generalizability as to its actual usage within a particular student.

This issue is closely related to the question of transfer within the educational and cognitive psychology research area (Marcus, Haden, & Uttal, 2018). In the 2010s, a relatively large quantity of research was published in which researchers attempted to train participants on cognitive functions that are theoretically very domain-general such as working memory (see Melby-Lervag & Hulme, 2013 for a meta-analysis). Of course, the data showed that continued engagement with such cognitive training did substantially improve participants' performance on the tasks or games on which the participants were practicing (Jaeggi, Buschkuehl, Jonides, & Perrig, 2008). Unfortunately, another resounding finding from this area of research was that the gains in ability that participants displayed were limited to the task on which they practiced, or very similar tasks (Sprenger et al., 2013). So, despite the cognitive training taking place on a task that was designed to measure an entirely domain-general ability, learning gains on that ability did not actually influence domain-learning in the way that was hypothesized. So, does that mean that the abilities trained were indeed domain-general or not?

One possible explanation for this effect that is relevant to the topic of this Handbook is that, in order to improve on cognitive training tasks, participants refined their task-specific strategies. These task-specific strategies may have allowed them to improve their performance on those particular tasks but did not allow for general gains on other tasks that were more nested within typical academic domains. Such a hypothesis highlights an interesting paradox concerning the tasks that are often used by psychologists to measure domain-general cognitive abilities (e.g., visuo-spatial reasoning tasks; Dumas & Alexander, 2016). While these tasks are not nested within a particular academic area and are therefore not highly influenced by prior domain-knowledge, they themselves constitute a sort of domain made up of similar tasks. For this reason, some have suggested that the quantification of general capacities should also be undertaken by examining the higher-order patterns among domain-specific measures, as opposed to only abstract tasks (Dumas & McNeish, 2017).

Within educational research on cognitive strategies, this problem is especially salient because, when we make practical recommendations to teachers, we must contend with the possibility that, although a particular cognitive strategy strongly supported student learning in our data, that strategy may not suffice to improve student performance across the range of tasks that students actually encounter in school and in life. For example, relational reasoning strategies are one body of cognitive procedures that have been empirically connected to student learning outcomes across a wide gamut of academic contexts ranging from elementary reading (Farrington-Flint, Wood, Canobi, & Faulkner, 2004) to medical residency (Dumas, Alexander, Jablansky, Baker, & Dunbar, 2014), and many instances in between. However, it is not yet known whether the fact that we can observe students engaging in relational reasoning across those learning contexts means that relational reasoning instruction, if abstracted from domain-specific academic material, would be effective at improving student performance across many domains (Dumas, Alexander, & Grossnickle, 2013). Although future work is necessary to address this research question, I would hypothesize that domain-general relational reasoning instruction would not necessarily improve student performance across all of the domains in which relational reasoning is known to play a role. Instead, it may be that, over the course of domain-learning, students must develop sophisticated strategies for identifying patterns within the information they interact with (i.e., relational reasoning strategies), and that is why the strategies appear so relevant across domains. In this way, a strategy that appears domain-general may actually have developed within a specific domain for a particular student. This issue is related to a further theoretical area that is relevant to the domain-generality of strategies and skills: the way in which the development of expertise influences learners' ability to apply strategies across (as opposed to within) domains.

DOMAIN-GENERALITY AND EXPERTISE DEVELOPMENT

It has been known for decades that experts in a particular domain of learning are more strategic in their thinking within that domain than are novices (see Dinsmore, Hattan, & List, 2018 for a meta-analysis). In addition, as already described, the strategic learning gains made by students who are on the path to expertise are hard-pressed to transfer across domains (Sprenger et al., 2013). However, one aspect of this issue that is less well understood is if, as individuals progress towards expertise, they become more capable of abstracting their developing domain- and task-strategies, or if the inverse is true: that the process of expertise development implies the deepening of strategic processing but does not significantly influence an individual's capacity to apply those strategies across domains.

To use an analogy to explain this point, in their theoretical article on the question of "What is learning anyway?", Alexander, Schallert, and Reynolds (2009) analogically likened the learning process to the process of topographical erosion from a river. In this analogy, learning experiences shape the mind of the learner much as the river erodes a landscape. Using this analogy, it is easy to imagine how certain experiences can have a deep and lasting effect on a student, much as a flood has a deep and lasting effect on a landscape, while other experiences have little effect. Further, it is also clear that certain individual differences within students make them more resistant or sensitive to learning from the environment, much as certain materials (e.g., rocks) are more resistant to influence from the river, while other materials (e.g., mud or sand) are more easily eroded. So, using this analogy, we can ask if the erosion-like process of expertise development must result in a steep domain-specific canyon, or conversely, if a wide domain-general flood-plain is also a possibility. For an individual learner whose knowledge was generalizable so as to analogically resemble a floodplain, would they be recognized as an expert within a particular domain of knowledge, or perhaps more importantly, as an expert participant within a discipline?

One commonly cited proposition that is relevant here comes from the very early days of research on the domain-generality of cognitive skills and abilities. Spearman's law of diminishing returns states that, as expertise develops within a specific domain, the domain-general strategies and skills that supported their earlier thinking and learning (such as those that are applicable to traditional intelligence tests) become less and less relevant. This supposition has been supported by empirical findings many times since (see Blum & Holling, 2017 for a meta-analysis). To incorporate this tenet into Alexander and colleague's erosion analogy, the development of expertise would be likened to the creation of a deep canyon. When a deep canyon is present on the landscape, new environmental forces such as rain are highly likely to be channeled through that canyon, focusing the erosion in one specific area. Following the analogy, if the learning process has created expertise within a particular domain, stimuli from the environment are highly likely to be interpreted in light of that expertise and be processed using strategies and skills that arise within that domain-specific learning. Using this line of theoretical reasoning, I would hypothesize that experts in a particular domain may not be any more likely than more novice students to transfer strategies and skills across domains. One likely exception to this pattern may lie with strategies that are specific to the domains of reading and writing, because they have high relevance across many domains and within nearly any discipline of expert practice (Graham, Harris, Kiuhara, & Fishman, 2017; McNamara, 2012).

FUTURE DIRECTIONS AND CONCLUDING THOUGHTS

Strategies and skills, as forms of procedural knowledge, are the actual processes that students do in order to improve their learning or achievement in school (Dinsmore, 2017). As has been discussed over the course of this chapter, there are a number of caveats that complicate the way that students evoke their procedural knowledge within and across domains learning. For example, procedures can be effortfully utilized (i.e., strategies) or automatized (i.e., skills) and that level of automaticity can vary within a student across domains, even for the same strategy. In addition, even though the same strategy can be identified as useful to students learning one domain as well as different students learning another domain, it may also be that a single student who is capable of successfully applying a strategy in one domain will not be capable of doing so in another domain. Further, the same student, as they develop expertise in a particular domain, may be more or less capable of transferring their strategic processes across domains, or if they do transfer, those strategies may be differentially effective for that learner across those domains. The type of learning context (e.g., task, domain, or discipline) also determines the specificity or generality of strategies wherein some task-specific strategies, if that task arises across domains, may be considered domain-general, and some strategies that can be useful across domains can be enacted very differently across disciplines, leading to a disciplinarily distinct strategic process.

Although the number and complexity of these caveats, and the others discussed in more detail earlier in this chapter, appear to undermine the systematic and empirical study of strategic processes, I would argue that, instead, they point to the richness of this research area and the possible fruitfulness of future inquiries into strategy use. Indeed, any psychological and educational study that goes beyond the quantification of performance or the measurement of ability to a finer grained look at what students actually do when they are thinking and learning, can meaningfully add to the current knowledge about the domain-generality and specificity of strategic processes. For example, it seems apparent that there is a continued need for a longitudinal perspective on strategy and skill development, not just in theorizing but also in empiricism. Most longitudinal work in psychology measures performance on tasks designed to indicate a construct that students have and develop (see Fryer & Vermunt, 2018 for an exception), but the actual procedural shifts students make in order to improve their performance on such tasks may be more interesting and relevant to education than is task performance. One longitudinal perspective that has begun to address this concern is called Dynamic Measurement Modeling (McNeish & Dumas, 2017), and this area of research shows the process for determining the generality of learning strategies, but definitive studies remain in the future.

In addition to a longitudinal or time-series perspective on strategy use, the inclusion of biometric data such as eye-tracking, skin connectivity, or neurological blood flow into studies of strategic processing also appears to be necessary and interesting. When incorporated with cognitive or behavioral data, such biometric markers may aid the field in determining how students evoke strategies when they are engaged in learning. For example, some recent attempts to combine strategic processing codes from think-aloud data, eye-tracking indicators, as well as academic performance, have been able to make novel inferences about reading strategies (Catrysse et al., 2018). In my view, this multi-faceted measurement approach will be particularly useful going forward in this line of inquiry.

For psychologists that study education, a focus on student performance or abilities across domains of learning is not sufficient to determine how students actually engage with tasks to enact their performance. Perhaps even more importantly, a focus on performance and ability does not provide the needed information to determine how instruction can be designed to improve learning outcomes because, without knowing the cognitive procedures by which students improve their performance, we cannot instruct students at the fine-grain procedural level. For this reason, research on strategic processing is absolutely necessary in educational psychology. However, even a sequence of well-designed studies of strategic processing within a single domain of learning cannot determine whether or how strategic knowledge in one domain can transfer to another, or even more so, whether direct instruction on strategies that are designed to be domain-general will actually improve student performance across a variety of domains. For this, targeted work focused on the domain-generality or domain-specificity of strategic processes is necessary.

Throughout the history of educational psychology as a discipline, researchers have sought to identify attributes of learners that would improve their learning and performance not only in one domain of learning but across the gamut of their academic activities (Alexander, 2018). The promise of such domain-general capacities has, in short, been that if students can improve on a domain-general ability, their performance will subsequently increase across multiple domains of learning. However, a finer-grained research approach into the actual cognitive procedures (i.e., strategies and skills) that students enact while thinking and learning has challenged this belief. For example, we now know that even procedures that appear highly generalizable do not readily transfer across domains (Sprenger et al., 2013). For this reason, the research area concerning strategic processing within and across domains, individual students, and expertise development stages currently holds many open questions. But it also remains clear that the evidence-based answers to these educationally relevant questions may be the only way to provide clear and actionable instructional recommendations to practitioners about strategy instruction. Therefore, research attention to the domain-generality and domain-specificity of strategic processes must continue in service of a central disciplinary goal of educational psychology: to support the learning of all students.

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3

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.