Introduction

Motivation and Its Relation to Learning

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This volume brings together chapters that address present understanding of motivation and learning, as well as the relation between them.[1] Neuroscientists, learning scientists, and developmental, educational, and social psychologists have contributed chapters, in which they describe research on motivation and learning, its potential to contribute to practice – both in and out of school – and future directions for inquiry.

Historically, research on motivation explores conscious as well as unconscious (implicit) responses to social and cultural circumstances, the will to engage (connect, participate), the influence of feelings about the self (self-concept, self-efficacy) and the work needed to address those feelings (self-regulation, self-motivation). It includes whether and when information search, rewards, incentives, or choice are operative, as well as the contributions of interest and internal motivation, curiosity and boredom, and goals and values.

Research addressing learning is similarly broad, in that it encompasses a wide range of foci. It addresses how and when individuals engage their attention, recognition and recall memory, and information processing (self-specificity, perception, affordances), as well as the acquisition and use of learning strategies. Research on learning also considers outcomes that can range from sustained participation and interest to achievement and deeper learning.

Even though motivation and learning are always mutually supportive, research that considers their relation has tended to focus on how motivation contributes to learning. For example, researchers have shown that (a) proximal goals motivate individuals, leading them to increased effort and improved performance (e.g., Bandura & Schunk, 1981; Zimmerman & Kitsantas, 2002); (b) developing and well-developed interests facilitate learning (e.g., Harackiewicz et al., 2008; Jansen et al., 2016); and (c) rewards contribute to increased attention and have cognitive benefits, such as improving memory for events due to enhanced dopaminergic activity in the midbrain and hippocampus (Adcock et al., 2006; Anderson et al., 2011). Researchers

1 All references to the contributing authors' work refer to their chapters in this handbook, unless otherwise noted.

in the learning sciences have examined the role of context and culture to provide detail about commonalities and their potential to inform design (e.g., the quality of interactions, activities in the learning environment; see Järvelä & Renninger, 2014). Together, findings from these approaches provide a basis for understanding how deeper learning may be promoted, and how unmotivated learners, in particular, can be enabled to meaningfully engage with content.

Consideration of how and when motivation can support learning is especially timely, as declines in students' motivation, interest, and value for academic subjects have been widely reported in recent years (Frenzel et al., 2010; Hidi & Harackiewicz, 2000; Hyde et al., 2016; Rosenzweig & Wigfield, 2016). In fact, in their review of the literature, Lazowski and Hulleman (2016) concluded that declines in student motivation span grade levels, beginning in elementary school, and are a systemic problem that threatens educational equality.

Furthermore, attention is needed that focuses on how the development of learning may change motivation. Some scholars have recognized that knowledge acquisition – even when it is not voluntary – can have positive motivational outcomes. For example, having students take physics courses that they would not choose on their own may expose them to ideas that promote learning and voluntary re-engagement.

Emerging neuroscientific work helps us explain why motivation functions as it does and, specifically, how it contributes to learning. One of the best examples of such findings – one that is reported in several chapters of this volume – reveals information-seeking to be an intrinsic reward that activates the reward circuitry in the brain just as extrinsic rewards do. This finding is critical for explaining the way motivation can lead to learning without extrinsic rewards. As Hidi (2006, 2016) pointed out, the relevance of neuroscientific findings has tended to be underestimated by social and educational psychologists, particularly in the area of motivational research. Indeed, many educational and social psychologists have argued for skepticism about how neuroscience can be relevant to educational practice and policy (e.g., Bruer, 1997).

Thus, although neuroscientific research has examined a plethora of issues about the human brain that are relevant to motivation and learning, the findings from this literature, by and large, have not been integrated with psychological research. For example, Rushworth et al. (2011) defined the areas of the brain that are critical in learning about reward associations, selecting reward goals, choosing actions to obtain rewards, and decision-making. This article is not cited in many papers on these topics in the motivation literature. Another example is the neuroscientific research on the reward circuitry: the literature on this topic contains hundreds of investigations that only recently have begun to be seriously considered by learning scientists and psychologists.

The importance of neuroscientific research has become obvious in the last two decades, and specifications of neural substrates of information processing have led to findings that behavioral investigations have not been in a position to provide. The benefits of linking neuroscientific research to domain-specific educational investigations are many. For example, De Smedt et al. (2010) demonstrated the relevance of cognitive neuroscientific research for mathematics education. Neuroscientific examinations are now able to provide information about the way that various circuits in the brain are activated. As such, they provide more direct observation of motivation than was available when Kanfer (1990) wrote that motivation is not directly observable and suggested that we can only observe behavior and infer motivational processes. In turn, the learning sciences – and developmental, educational, and social psychologists – are positioned to provide neuroscience with information about variables on which to focus their studies: which variables, in which contexts, have already been identified as critical, and open questions that neuroscience may be in a position to address (De Smedt et al., 2010).

Describing the scientific and pragmatic challenges of bridging education and neuroscience, Varma et al. (2008) suggested that neuroscientists and educational researchers should view themselves as collaborators, rather than competitors, in the pursuit of knowledge. This handbook has been compiled in the spirit of this suggestion.

In undertaking the editing of this volume, we had in mind commonalities that are present in the published findings of domains that have traditionally been distinct. We specifically invited contributions from those whose work, in juxtaposition with others', would enable readers to consider their synergies. Chapters in this handbook have been organized into six sections: I. The Self and Its Impact; II. Rewards, Incentives, and Choice; III. Interest and Internal Motivation; IV. Curiosity and Boredom; V. Goals and Values; and VI. Methods, Measures, and Perspective.

The reader may note that many of the chapters address more than a single topic and could have been assigned to more than one section. This situation reflects a movement toward consideration (or the integration) of topics across and within fields that formerly had been isolated or siloed. For example, in Chapter 21, Chiew and Adcock use neuroscientific methods to show the critical role of motivation in encoding information in long-term memory. They describe the pursuit of learning goals based on their interrogative/imperative model of information-seeking. Although they are addressing goals and values, their chapter also involves serious consideration of reward, incentive, and choice, as well as curiosity and boredom. As such, their chapter could easily have been included in a number of sections. Similarly, in Chapter 15, Schwartz and Wrzesniewski distinguish between activities that are internally motivated (pursued for consequences related to the activity itself that can yield lasting effects on well-being) and intrinsically motivated activity (undertaken due to

pleasure). Their chapter appears in the section concerning interest and internal motivation. However, it could have been assigned to the section on rewards, incentives, and choice, or that on goals and values. In fact, most of the chapters in this volume bridge a number of topics.

In making section assignments, we chose to facilitate readers' consideration of differences and synergies in conceptualizations, questions, and approaches. Readers will also notice that some chapters address the same construct (e.g., boredom, curiosity, goals), yet represent distinct points of view and differing research questions or methods. For example, in Chapter 19, Goetz and his colleagues report on the negative consequences of boredom (defined as an emotion) and ways by which those consequences could be avoided; whereas, in Chapter 20, Mugon et al. investigate the state of boredom as a signal of disengagement rather than as a cause of disengagement. This is not a case of one group of researchers being more correct than another; rather, each view presents a different focus and related questions.

Readers will also note that the concept of curiosity is addressed in several different chapters. In Chapter 16, Gruber et al. first discuss trait curiosity (i.e., curiosity that is considered to be a specific personality characteristic). Subsequently, they describe neuroscientific research that demonstrates the memory benefits of information-seeking during temporary states of curiosity. These benefits were established not only for associated information, but also for incidentally encoded information. In Chapter 17, Litman, who describes two types of curiosity (interest and deprivation), examines the relation between trait and state measures, and weighs the implications of neuroscientific findings for his model. Finally, in Chapter 18, Shin et al. lay out reasons to distinguish between interest and curiosity (see also Grossnickle, 2016), although they acknowledge that both can have a positive impact on individuals' motivation, learning, creativity, and well-being.

In the sections that follow, we point to some of the themes that emerge and to future directions that the respective research suggests. We pose no grand theory in this handbook. Rather, readers are invited to partner with an incredible group of authors to think on both the breadth and depth of available research on motivation and learning.

Emergent Themes

Across the chapters, several emergent themes can be identified. These include: integrative approaches to inquiry (across and within domains); the centrality of reward in human functioning; the importance of personal connections, social practices, and cultural identities; and the need to reconsider methods and measures. We review each of these themes next, drawing examples from this volume. We note that not all instances are mentioned, and that the examples we do provide may not come from the same sections.

Integrative Approaches

Fields (or domains) and topics that, in the past, have been studied as distinct because of differences in researchers' training and methods, are now beginning to be considered in relation to each other. We found that some form of integration characterizes all of the chapters in this volume in one way or another, suggesting that authors' efforts to contextualize their foci in relation to others' may be a harbinger of new directions in the field. Here, we point to examples of this integration across domains as well as between psychological constructs.

Across domains. In Chapter 6, Murayama points out that cross-disciplinary work between neuroscience and psychology is vitally important for understanding motivation and learning, and provides a rationale for studies of incentives. He explains that whereas neuroscientists have determined that extrinsic and intrinsic incentives form a single psychological process, psychologists have tended to focus on the differences between the two types of incentives. Murayama concludes that these two perspectives should productively inform each other.

Another example of integration across domains involves affective neuroscientific research on self-related information processing; in Chapter 1, Hidi et al. consider how it is related to rewards and interest. They also point to its potential to explain why an educational intervention (such as utility-value) is beneficial for some individuals but not for others. Similarly, in Chapter 10, Patall and Hooper's discussion of choice provision highlights motivational, cognitive, social, and neuroscientific perspectives, which provide a complex picture of the role of choice in educational settings. For example, they explain that the broader social and interpersonal context can change the meaning and effects of choice.

Between psychological constructs. In their discussions of psychological constructs, the authors of some chapters in this volume also reflect the movement toward integration. However, rather than integrating across domains, the focus in these chapters is between topics within the domain of psychology. For instance, in Chapter 2, Marsh et al. describe their studies of academic self-concept in the context of positive psychology. Their multifaceted model of academic self-concept includes multiple aspects of the self: academic, social, physical, and emotional. Similarly, in considering the relationship between interest and conscientiousness, in Chapter 14, Trautwein et al. draw on two psychological literatures that have been almost completely distinct: personality and educational psychology. They introduce and provide evidence for the Conscientiousness × Interest Compensation (CONIC) model, in which they describe how conscientiousness and interest at least partly compensate for each other in predicting academic achievement. Finally, in Chapter 24, Rosenzweig et al. discuss the relation among psychological constructs in their review of expectancy-value theory (Eccles et al., 1983). They describe findings demonstrating the

development of expectancies, task values, and perceptions of cost, as well as their implications.

In Chapter 29, person-oriented approaches, in which variables are studied in combination within a person, represent yet another form of integration that offers additional insight about educational outcomes. Linnenbrink-Garcia and Wormington point out that motivation in classrooms is far more complicated than variable-centered analyses (e.g., analyses that focus on a single motivational variable such as self-efficacy) can describe and address. They present an integrative, person-oriented approach for studying student motivation. In Chapter 23, Niemivirta et al. further elaborate on the benefits of a person-oriented approach, focusing on its use in the study of multiple goals to address a long-standing debate in the literature on the advantages of endorsing different goals. Niemivirta and his colleagues state that person-centered approaches allow study of the individual as an active agent, as well as developments in individual learning and engagement over time – information that they note as critical for both researchers and practitioners.

Chapter 11, our chapter on interest development and learning, provides an illustration of how person-oriented, or within-person, analyses extend findings from previous variable-centered studies. We point to findings detailing a distinct set of relations among learner understanding, effort, feedback preferences, goals, self-efficacy, and self-regulation for each of the four phases of interest development. As our discussion demonstrates, integrative findings of this type have implications for theory building and research, as well as practice.

The Centrality of Reward in Human Functioning

Neuroscientists have established that the reward circuitry in the brain involves dopaminergic systems related to motivation and value, as well as cortical systems related to attention and memory. Reward anticipation and receipt of rewards activate this circuitry, suggesting that understanding the relation between motivation and learning results in having to acknowledge centrality of reward in human functioning. Several contributors consider the motivating power of such activation, and its effect on learning and performance.

An example of a dopamine-dependent motivational process, incentive salience, is the focus of Chapter 7, by Anselme and Robinson. They provide evidence that incentive salience not only plays a direct role in determining individuals' responses, but also contributes to the variability of performance that learning alone cannot explain. Furthermore, Anselme and Robinson relate the invigorating effect of reward uncertainty to incentive salience, and they introduce the novel construct of incentive hope to explain its power.

For years, research on incentives has been focused on extrinsic rewards. However, findings from neuroscience indicate that extrinsic and intrinsic rewards activate the same areas in the reward circuitry (see Gottlieb et al.,

2013; Murayama, Chapter 6). Subsequently, findings on intrinsic rewards established that searching for information is such a reward. Curiosity and interest that are both associated with information search are intrinsically rewarding.

Contributors addressing these topics acknowledge the power of intrinsic rewards. For example, in Chapter 8, Dey and Gottlieb consider intrinsic rewards and information-seeking. They focus on the neuroscience of attention and describe the mechanisms coordinating individuals' decision-making, beliefs, goals, and actions. They suggest that attention is used to reduce uncertainty and obtain reward, and they explore the role of cognitive control in directing attention. They also point to the strong reward-dependent attentional effects related to novelty and introduce the concept of savoring, which explains that people obtain utility not only from actual rewards they receive, but also from future-oriented "anticipatory" feelings. Both the concepts of incentive hope and savoring touch on strong motivation related to anticipation of rewards.

In Chapter 9, Hickey and Schenke do not deal with the neuroscientific findings of rewards but focus on the educational relevance of a particular type of incentive: the use of digital badges for tracking and sharing accomplishment online. They distinguish the use of badging from many people's working assumptions about the negative effects of extrinsic rewards and point, instead, to findings indicating the utility and transparency provided by badging systems, especially in inquiry-based environments.

Social Practices and Cultural Identities

A recurring theme in the chapters written by learning scientists and developmental, educational, and social psychologists is the essential role of social practices and cultural identities in motivating engagement and learning. For example in Chapter 12, Ito et al. describe the connected learning that occurs in online affinity networks (online communities that share a specific focus) as motivating learning and promoting interest development. They point to the roles of shared interests, identity, culture, and values as binding people together, and to shared practice as providing a focus of activity and engagement. Similarly, in Chapter 5, Larson et al. characterize effective after-school programming as sustaining motivation by providing opportunities for adolescent youth to develop relationships and have experiences that promote feelings of competence and camaraderie.

In Chapter 13, Alexander et al. using longitudinal data, provide evidence that with support from other people such as peers, parents, and teachers, the potential to trigger and maintain interest in science exists in every developmental time period. In order for social context and practices to support learners at different points in their development, understanding

the way those learners ascribe meaning is essential. In Chapter 30, Shell and Flowerday describe how people learn from the affordances that are available and that they perceive. They point to the impact of culture on the opportunities and affordances and its subsequent impact on the processes involved in knowing and motivation, as well as what is learned.

In Chapter 22, Nolen focusing on the goals that people have and develop, explains that goals are not context-free. She points to the range of ways in which goals have been studied (e.g., in relation to action, beliefs across settings, or a more situated analysis of how goals are specific to context) and calls for studying goals in relation to the systems of meanings under study. In Chapter 25, Canning and Harackiewicz consider mechanisms that explain the success of utility value interventions. They point, in particular, to the possibility that background knowledge may be critical. This is not the same point that Nolen makes, but the role of learner understanding is critical to each consideration. Similarly, in Chapter 4, Sansone et al. draw on the Self-Regulation of Motivation (SRM) model to demonstrate how experiencing interest is both a process and an outcome, and provide an explanation of the role of individual differences (e.g., having an interpersonal orientation) in goal adoption and strategy use. They also explain that the anticipated, perceived, or experienced congruence between a student's goals, and the way that science, technology, engineering, and math (STEM) learning tasks are presented and structured, can be an important source of student motivation to begin and persist in learning, and may influence whether and how students attempt to make learning tasks more interesting.

In Chapter 3, Ahn and Bong in reviewing the literature on the development of self-efficacy beliefs and the relation between self-efficacy and other constructs (such as motivation, strategy use, self-regulation, and achievement)also point to the possibility that before their self-efficacy beliefs start shaping motivation and learning, students need to understand the characteristics of the school subject. These authors also suggest that differences in educational systems and policies need to be considered in studies of the use of self-efficacy information that have been attributed to cultural diversity.

Methodological Considerations

All of the chapters in this handbook address the methods and measures used in motivation research and point to needed adaptations and consideration. In Chapter 26, Ainley and Ainley review the methods and measures being used to study motivation, pointing to the expansion of tools and techniques that are available to researchers. They provide detail about their use, data reduction, analyses, and point to the increasing interest of motivation

researchers in acknowledging the interactive influences of the person and context. They also underscore the need for researchers to align the methods and measures they employ with their research questions, rather than relying exclusively on various forms of self-reports to provide information about motivation and learning. In Chapter 27, Fredricks et al. review examples of the measures employed in the study of engagement specifically and the challenges of each. Subsequently, decisions to combine methods to address measurement challenges in their studies are explained. They describe the use of interviews and focus groups to validate a survey tool, and the use of observational approaches to measure behavioral engagement, along with tests of their predictive validity.

In Chapter 28, Kosovich et al. also draw on examples from their own work to illustrate the application of pragmatic measurement, which involves adapting commonly accepted measurement practices to situational constraints (e.g., limited time for survey completion) that are common to data collection in educational settings. They argue for the utility of pragmatic measurement in educational settings, where it can address research questions as effectively as high-quality measures that require substantial resources.

Concluding Thoughts

The chapters of this handbook provide a foundation for considering both present knowledge and the next steps for understanding motivation, learning, and the relation between them. As we noted earlier, we propose no grand theory, but our sense is that this handbook makes a case for encouraging consideration of the synergies that can be identified when topics are considered across and within domains. Considering similarities and differences in findings about topics in motivation and learning, as well as the relations that exist among them, is critical if research is to inform policy and practice.

Some open questions include:

- How can researchers working on related constructs, but with different perspectives, find common ground?
- How are beliefs, goals, and expectancies – all conscious – related to possibly unconscious motivation, such as incentive salience?
- How is motivation, such as striving for excellence, related to neuroscientific research?
- How are cultural influences related to reward anticipation?

It is our "incentive hope" that the chapters of this handbook will lead researchers to undertake investigations that can answer these questions and the many more that can be generated in the course of reading.

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