Educational Psychology Review (2023) 35:54
https://doi.org/10.1007/s10648-023-09774-w

# Integrating Motivation and Instruction: Towards a Unified Approach in Educational Psychology

**Andrew J. Martin**[1]

Accepted: 27 April 2023 / Published online: 9 May 2023


**Abstract**

Motivation and instruction are two major substantive domains in educational psychology. Theory and research relevant to each of these domains tend to be diffuse and fragmented. This presents challenges for scholars and practitioners seeking to implement parsimonious and cohesive approaches to help students to learn. This review articulates a two-step integration process that is an illustrative effort towards tackling these challenges and unifying two psycho-educational domains: *intra*-domain integration (within each of motivation and instruction) and *inter*-domain integration (between motivation and instruction). With respect to motivation, the Motivation and Engagement Wheel (Martin, 2007) is presented as an example of *intra*-domain integration of key facets of motivation (Step 1a). With respect to instruction, Load Reduction Instruction (LRI; Martin, 2016; Martin & Evans, 2018) is an example of *intra*-domain integration of explicit instruction and guided independent learning (Step 1b). The review then proposes an *inter*-domain integration of motivation and instruction (Step 2), arguing that each domain is tied to the other. The joint operation of *intra*- and *inter*-domain integration of motivation and instruction holds potential for more coherent theorizing, measurement, and practical application.

**Keywords** Motivation · Engagement · Motivation and Engagement Wheel · Explicit instruction · Discovery learning · Cognitive Load Theory · Load Reduction Instruction

✉ Andrew J. Martin
andrew.martin@unsw.edu.au

[1] School of Education, University of New South Wales, Sydney, NSW 2052, Australia

## A Two-Step Approach Towards Unifying Educational Psychology

Motivation and instruction represent two major substantive domains in educational psychology (Jansen et al., 2022). Unfortunately, these domains—and, hence, educational psychology—continue to be hampered by a common problem: approaches to their conceptualizing, assessment, and application are diffuse, piecemeal, and fragmented (Dweck, 2017; Hattie et al., 2020; Murphy & Alexander, 2000; Reschly & Christenson, 2012; Wong & Liem, 2021). For example, motivation research is populated by diverse theories and multitudes of constructs (Wigfield & Koenka, 2020); meanwhile, research into instruction traverses approaches as divergent as direct and explicit instruction through to pure discovery learning (Dean & Kuhn, 2007; Klahr, 2009). This can present problems for researchers and practitioners who seek to implement more parsimonious and cohesive motivational and instructional approaches to support students' educational development (Dweck, 2017; Hattie et al., 2020; Pintrich, 2003).

In striving to attain greater coherence in the domains of motivation and instruction (and then the field of educational psychology), this review articulates a two-step integration process that is an illustrative effort towards such coherence: *intra*-domain integration and *inter*-domain integration. *Intra*-domain integration is the first step and involves drawing together key concepts in each of motivation (Step 1a) and instruction (Step 1b) domains to develop a unified motivation framework and a unified instruction framework. *Inter*-domain integration is Step 2 and involves drawing together the two unified motivation and instruction frameworks into a unified educational psychology framework.

Based on this author's program of theorizing and research in motivation and instruction, the present discussion demonstrates one application of this hypothesized integration process. With respect to motivation, it presents and describes the Motivation and Engagement Wheel (Martin, 2007). The Wheel can be considered an *intra*-domain integration of key facets of motivation (and engagement) that are informed by diverse and salient motivational theories. With respect to instruction, the discussion presents and describes Load Reduction Instruction (LRI; Martin, 2016; Martin & Evans, 2018, 2021). LRI can be considered an *intra*-domain integration of (post)positivist instructional perspectives such as explicit instruction (Evans & Martin, 2021) and constructivist instructional perspectives such as (guided) independent or self-directed learning (Kuhlthau et al., 2015).

Then, with respect to educational psychology more broadly, the review describes a recent *inter*-domain integration of instruction and motivation that identifies the nexus between the Motivation and Engagement Wheel and LRI (Martin, 2016). A fundamental concept underpinning *inter*-domain integration is that the success of one domain (e.g., motivation) is tied to the success of the other (e.g., instruction). That is, motivation can be optimized by the presence of high-quality instruction and instruction can be optimized by the presence of highly motivated students. Figure 1 presents a schematic of the proposed *intra*- (Steps 1a and 1b) and *inter*-domain (Step 2) integration process—including representation of the cyclical relationship between motivation (and engagement) and instruction.

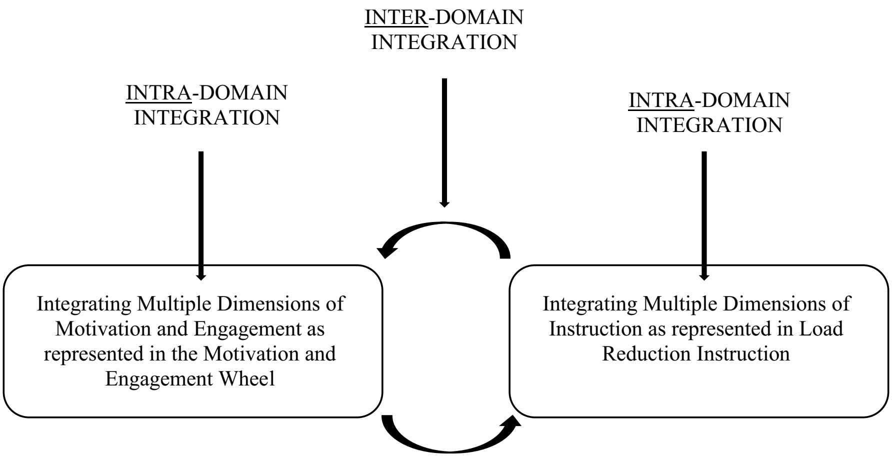


**Fig. 1** Intra- and inter-domain integration applied to (a) multiple dimensions of motivation and engagement and (b) multiple dimensions of instruction

It is contended that the joint operation of *intra*- and *inter*-domain integration of motivation and instruction within educational psychology holds potential for more efficient and effective theorizing, measurement, and application for scholars and practitioners alike.

The proposed contribution of this review is to articulate a process by which progress can be made towards organizing and integrating multiple theories in educational psychology (and to some extent, cognitive psychology). The purpose of the review is to systematically delineate two programs of integrative theorizing and research (one in motivation and the other in instruction) that have largely been conducted independently of each other—and that have recently been linked in an effort towards an integrative perspective on motivation and instruction. The review is thus something of a tentative and illustrative meta-view of how a potential motivation-instruction framework can be developed over time, emanating from distinct theory- and construct-specific foundations.

In the course of the review, consideration is also given to five issues that help further elucidate this *intra*- and *inter*-domain cross-fertilization of motivation and instruction: (1) identifying points of convergence and divergence to underpin an integrative synthesis of key principles and ideas, (2) accounting for the joint operation of individual student attributes and learning environment as a rationale for integrating motivation and instruction, (3) addressing complementary gaps and harmonizing competing ideas as theories and frameworks are synthesized, (4) providing validity evidence to support the feasibility of the integrative framework, and (5) acknowledging important and influential boundary conditions as the integrative framework is developed and applied in practice.

## Step 1a: Intra-domain Integration of Multidimensional Motivation and Engagement

### Theories Explaining and Describing Motivation and Engagement

In 2003, Pintrich identified key substantive questions to answer in the development of an integrative motivational science. One question, "what motivates students in classrooms?" concerns the theories that articulate situation-specific needs and motives relevant to students' academic development. They focus on achievement, classroom, and school-relevant beliefs of students and how they explain students' motivation for learning. Pintrich (2003) then emphasized the importance of considering motivation (and in parts, engagement) in terms of major theorizing related to: self-efficacy (and related expectancies), valuing, self-worth, need achievement, control, attributions, goal orientation, self-regulation, and self-determination.

A second question, "what do students want?" concerns the energization and direction of behavior. According to Pintrich (2003), core motivational theories explain what gets students moving and towards what activities or tasks. Thus, for example, these theories specify various needs that are met or satisfied (consciously or unconsciously) in the course of learning and instruction. Under social-cognitive, situated expectancy-value, and self-determination theories (Bandura, 2001; Deci & Ryan, 2012; Eccles & Wigfield, 2020; Ryan & Deci, 2010; Schunk & Mullen, 2012), for example, students' competence needs are met; under self-worth motivation theory (Covington, 2000), students' need for self-worth protection is met; under goal theory (Anderman & Patrick, 2012; Elliot, 2005), students' desires to master learning skills and content, outperform others, and avoid poor performance are met; and, under the classic need achievement theory (McClelland, 1965), the needs to attain success or avoid failure are met.

A third question, "how do students get what they want?" concerns the means and methods by which students translate their needs, beliefs, and goals into action. According to Pintrich (2003), this involves core functions central to motivation and engagement theorizing, including planning, task management, monitoring, and regulation of cognition, emotion, and behavior. Integrative motivational (and engagement) theorizing helps our understanding of what students want in terms of their academic development and how they go about getting it.

Accommodating Pintrich's (2003) three lines of thinking is an important step towards integrating core motivational concepts. Following his emphasis on key substantive questions to address and core concepts in motivational science (e.g., self-efficacy, valuing, need achievement, etc.), diverse motivation theories (including some that also speak to engagement) are briefly reviewed and then an integrative motivation and engagement framework (the Motivation and Engagement Wheel) is presented that represents an *intra*-domain integration of this diverse theorizing.

#### Social Cognitive, Self-determination, and Expectancy-Value Theories

Self-appraisals of one's competence feature in several motivation theories. These appraisals variously comprise factors such as perceived competence, self-concept, self-efficacy, and self-expectancies. Self-efficacy is one of the more salient of these and is closely associated with the seminal social-cognitive theory (Bandura, 2001; Schunk & DiBenedetto, 2020; Schunk & Mullen, 2012; also see Marsh, 2007 for a review of self-concept; Harter, 1999 for a review of perceived competence). Self-efficacy refers to students' appraisals about their task-specific academic capacity.

Self-determination theory (SDT; Deci & Ryan, 2012; Ryan & Deci, 2010, 2020) also places perceived competence as central to its formulation. SDT emphasizes the importance of having basic psychological needs met to realize academic and personal wellbeing (Reeve, 2012). Three needs are identified as especially vital: the need for relatedness, the need for autonomy, and the need for competence. The latter (need for competence, or self-efficacy) is directly relevant to self-appraisals of competence. The need for autonomy is also a motivational construct and comprises aspects of agency that are in part implicated in perceived competence, with some additional alignment to perceived control (described below). The need for relatedness (although implicated in motivation) is suggested as an inter-personal factor that lies outside this review's motivation framework that focuses on intra-personal student attributes, not interpersonal dynamics.

Expectancy-value theory (and more recently, situated expectancy-value theory) is another perspective that incorporates competence appraisals (Eccles & Wigfield, 2020; Wigfield & Eccles, 2000) positing that students are motivated when they have high task-related self-expectations (or, self-efficacy). Importantly also, students' motivation is a function of how much they value a task (or education more broadly). The combined effect of positive expectations and valuing has adaptive implications for students' academic development (Eccles & Wigfield, 2020; Martin et al., 2017; Wigfield & Eccles, 2000).

### Need Achievement and Self-worth Motivation Theories

The dual motives to approach success and avoid failure are also germane to motivation theorizing and are captured by need achievement and self-worth theories (Atkinson, 1958; De Castella et al., 2013; Covington, 2000; McClelland, 1965). This theorizing identifies three major student typologies: success-oriented students, failure-avoidant students, and failure-accepting students (Martin & Marsh, 2003). Success-oriented students are proactively oriented and are energetic and optimistic in the face of academic setback (Martin et al., 2003). Failure-avoidant students are characterized by a fear of failure that can manifest in several ways, such as self-handicapping (i.e., actively diminishing one's chances of success in order to have an excuse or alibi in case of poor performance—e.g., through inadequate preparation or procrastination; Covington, 2000; Martin & Marsh, 2003). Failure accepting students have abandoned effort and become disengaged or helpless (Covington, 2000).

### Goal and Self-regulation Theories

Goal theory is focused on the reasons students have for engaging in their achievement-related behaviors (and has some roots in both need achievement and self-worth theories). Seminal goal theory distinguishes between mastery and performance goals, with subsequent theorizing expanding on this to incorporate approach and avoidance dimensions (Anderman & Patrick, 2012; Elliot, 2005; Urdan & Kaplan, 2020). Mastery approach refers to a motivation towards understanding, learning, and mastery; performance approach reflects a motivation towards demonstrating relative ability and outperforming others; performance avoidance refers to a motivation to avoid appearing incompetent or to disappoint others; mastery avoidance reflects a motivation to avoid a loss of competence, skill, or knowledge (Elliot, 2005). The role of self-regulatory behaviors in operationalizing goals is also relevant (Usher & Schunk, 2018). For example, theorizing around self-regulation has identified numerous engagement factors by which mastery goals are enacted in students' academic lives (Lin, 2019)—including factors such as planning and monitoring, task management, and persistence (e.g., Zimmerman, 2002; Zimmerman & Campillo, 2003; see also Pintrich, 2003).

### Attribution and Control Theories

How students perceive the causes of their success and failure has significant implications for their academic motivation (Weiner, 2010; see also Graham, 2020). Attribution theory elucidates how a perceived cause of past outcomes can impact subsequent cognition, behavior, and emotion. According to attribution theory, causes typically vary as a function of three main dimensions: stability (stable or unstable cause), locus (internal or external cause), and controllability (controllable or uncontrollable cause; Weiner, 2010). The control dimension has received significant scholarly attention (e.g., Skinner, 1996; Skinner & Zimmer-Gembeck, 2011) and refers to a belief that one has a meaningful influence on attaining success or avoiding failure (and some alignment with the experience of authorship and autonomous agency under SDT; Ryan & Deci, 2020). Students who are uncertain in their sense of control tend to be unsure and shaky regarding their capacity to attain success or avoid failure (Collie et al., 2015; Patrick et al., 1993).

## Cross-fertilizing Theories of Motivation: Convergence, Divergence, and Synthesis

These diverse lines of theory have made significant contributions to describing and explaining academic motivation (and engagement). They also suggest specific factors to cross-fertilize to underpin a synthesis represented by an integrative multidimensional framework. Social-cognitive and self-determination perspectives suggest self-efficacy; (situated) expectancy-value theory suggests valuing (as well as self-efficacy); goal theory suggests approach and avoidance goals; self-determination theory suggests core psychological needs such as competence; self-regulation theories suggest planning, task management, and persistence; attribution and related control theories suggest control; and need achievement and self-worth motivation theories suggest factors such as self-handicapping and disengagement (Martin, 2007, 2016). Discussion now turns to convergences and divergences that are implicated in this cross-fertilization and how these different facets of motivation and engagement may be synthesized into a unified framework.

## Grouping Multiple Motivation and Engagement Factors

As Reschly and Christenson (2012) note, the motivation and engagement terrain is "murky" (see also Wong & Liem, 2021). Failure to synthesize key dimensions and dynamics risks leaving the field confused and muddied (Martin, 2012). It has been proposed that integrating multidimensional motivation and engagement can be achieved by identifying key points of convergence and grouping the multiple dimensions in three ways, according to their: internal and external status, adaptive and maladaptive status, and lower and higher order status (Martin, 2007, 2009). Each of these is discussed in turn, leading to a description of how these may be synthesized into a unifying framework.

### Grouping Motivation and Engagement in Terms of Internal and External Status

A set of commentaries in a major volume on engagement (Christenson et al., 2012) sought to clarify motivation and engagement. Many of these commentaries articulated something of a demarcation between the "inner" and "outer" dimensions of students' academic development. For example, Reeve (2012) observed that motivation comprises "private, unobservable, psychological, neural, and biological" factors, whereas engagement comprises "publicly observable behavior" (p. 151). Schunk and Mullen (2012) identified motivation as an internal force that energized outward engagement. Ainley (2012) posited motivation as an inner psychological dimension and engagement as one's involvement in an activity. Voelkl (2012) demarcated affective and behavioral factors implicated in students' academic development, with motivation aligned with the former and engagement with the latter. In a discussant piece for that volume, Martin (2012) concluded that considering motivation and engagement in terms of their internal and external properties is one means of converging them into more manageable (but distinct) groups. He thus proposed motivation as reflecting predominantly internal dimensions and engagement as reflecting predominantly external dimensions (see also Martin et al., 2017).

### Grouping Motivation and Engagement in Terms of Adaptive and Maladaptive Status

It has been suggested that motivation and engagement are not on a continuum from negative to positive; rather, negative and positive motivation and engagement reside on separate continua (divergent in valence). For example, Martin and colleagues (2012) proposed that addressing students' motivation and engagement requires attention to boosting distinct positive dimensions (i.e., factors that are convergent in positive valence) and reducing distinct negative dimensions (factors that are convergent in negative valence). Their study found that the predictive pathways to positive and negative motivation and engagement dimensions were empirically unique. Indeed, Skinner and Pitzer's (2012) work on engagement aligns with this. For each of cognitive, behavioral, and emotional engagement in their conceptualization, they identify both "engagement" and "disaffection" dimensions. Other motivational frameworks bifurcate positive and negative factors. Goal theory, for example, articulates adaptive "approach" dimensions such as mastery goals and maladaptive "avoidance" dimensions such as performance avoidance goals (Elliot, 2005), and need achievement and self-worth theories before it represented the motives to approach success and avoid failure (Covington, 2000; McClelland, 1965).

### Grouping Motivation and Engagement in Terms of Lower and Higher Order Status

Taking the above convergences and divergences (internal/motivation and external/engagement; positive and negative) together, Martin (2007, 2009) proposed and found (via higher-order confirmatory factor analysis) that motivation and engagement can also be characterized in terms of four higher order groups each representing converging dimensions of motivation and engagement: positive motivation, positive engagement, negative motivation, and negative engagement. Moreover, hypothesizing this higher order structure enabled a lower order representation of specific motivation and engagement factors—that is, specific factors that are subsumed under each of the four higher order dimensions.

### Synthesis: Developing an Integrative Motivation and Engagement Framework

Following from each of these grouping considerations, three major criteria can be advanced, and which provide the basis for synthesis leading to development of a hypothesized integrative motivation and engagement framework. First, motivation and engagement are distinct and multidimensional. Second, motivation and engagement dimensions can be demarcated into positive (adaptive) and negative (maladaptive) components. Third, specific and converging (lower order) motivation and engagement factors can be subsumed under broader (higher order) motivation and engagement dimensions. The Motivation and Engagement Wheel (Fig. 2; Martin, 2007, 2009; see also Liem & Martin, 2012) is an integrative framework developed to meet these criteria. The Motivation and Engagement Scale (Martin, 1999–2022) is a measurement instrument used to assess students on each part of the Wheel.[1]

[1] Although the Wheel and MES are the focus of this review, there are other frameworks that operationalize and assess multidimensional motivation and engagement. These include Patterns of Adaptive Learning Survey, PALS, by Midgley et al. (1997); the Motivated Strategies for Learning Questionnaire, MSLQ, by Pintrich et al. (1991); the Student Engagement Instrument, SEI, by Appleton et al. (2006); the Academic Motivation Scale, AMS, by Vallerand et al., (1992); and the Inventory of School Motivation, ISM by McInerney et al. (2001)—to name a few.

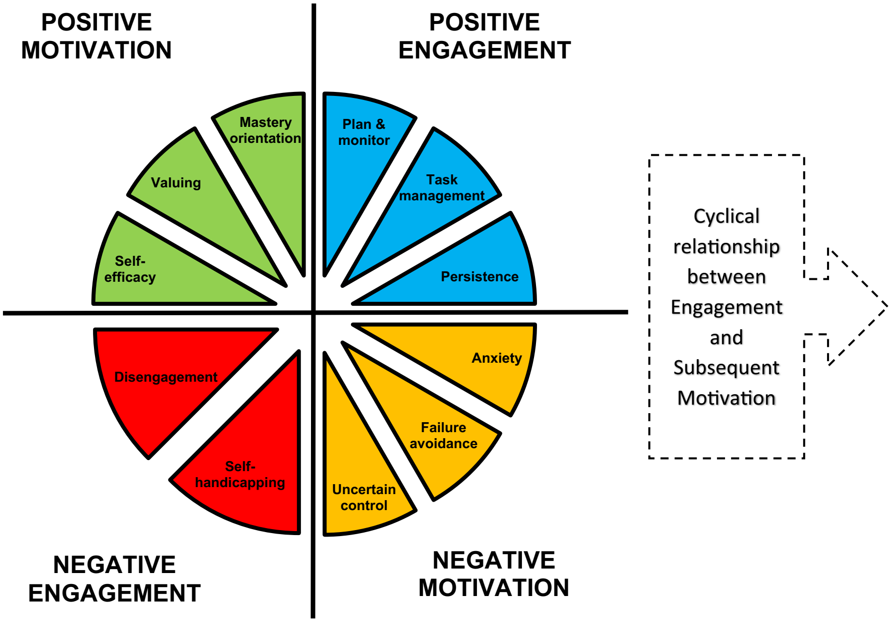


**Fig. 2** Motivation and Engagement Wheel (reproduced with permission from www.lifelongachievement.com)

## The Motivation and Engagement Wheel

There are four higher order dimensions and eleven lower order factors in the Motivation and Engagement Wheel. The four higher order dimensions are: positive motivation, positive engagement, negative motivation, and negative engagement. Positive motivation is a predominantly cognitive-affective dimension and comprises a set of convergent factors that reflect students' positive attitudes and orientations to academic learning, including (1) self-efficacy, (2) valuing, and (3) mastery orientation. Positive engagement is a predominantly behavioral dimension and comprises a set of convergent factors that reflects students' positive behaviors and engagement in academic learning, including (4) planning and monitoring behavior, (5) task management, and (6) persistence. Negative motivation is a predominantly maladaptive cognitive-affective dimension and comprises a set of convergent factors that reflects students' attitudes and orientations inhibiting academic learning, including (7) anxiety, (8) failure avoidance, and (9) uncertain control. Negative engagement is a predominantly maladaptive behavioral dimension and comprises two convergent factors that reflect students' more problematic learning behaviors, including (10) self-handicapping and (11) disengagement. Figure 2 graphically represents this synthesis comprising the four positive and negative higher order dimensions and the eleven specific factors subsumed under them.

For the purposes of illustration in this review, two integrative aspects of the Wheel are described. The first relates to the empirical synergies within each of the four overarching themes in the Wheel that would be hypothesized a priori. Most of the research utilizing the Wheel attends to its 11 component factors and confirmatory factor analysis shows that modelling these as distinct (but correlated) factors provides a good fit to data among elementary school students, high school students, and university/college students (Martin, 2009). However, higher order factor analysis shows that the a priori thematic clustering of factors within each of positive motivation, positive engagement, negative motivation, and negative engagement also represents a good fit to data. There is thus empirical alignment among the hypothesized motivational constructs that is distinct from the empirical alignment among the hypothesized engagement constructs.

Building on this, the second aspect of integration relates to how these higher order factors are connected to each other. Christenson et al. (2012) curated a series of reviews by researchers elucidating the distinctions and alignments between motivation and engagement (e.g., see Ainley, 2012; Reeve, 2012; Schunk & Mullen, 2012; Voelkl, 2012 in that volume). One major conclusion from those reviews was that motivation was often an impetus for subsequent engagement. Harnessing data collected around the Wheel, Martin et al. (2017) tested this contention. They found support for the claim that prior motivation is an impetus for subsequent engagement; but there was also support for a role for prior engagement predicting subsequent motivation, ultimately indicating a cyclical process. Taken together, the Wheel reflects integration by way of strong empirical alignments *within* (positive and negative) motivation and *within* (positive and negative) engagement as well as integration by way of empirical connections *between* motivation and engagement (including cyclical relations between engagement and subsequent motivation; see Fig. 2) that have a priori conceptual foundations.

### The Motivation and Engagement Scale

The Wheel is a conceptual framing of multidimensional motivation and engagement. It is accompanied by a parallel measurement tool—the Motivation and Engagement Scale (MES; Martin, 1999–2022)—that comprises 44 items (4 items for each of the 11 factors) for students to self-report their motivation and engagement (also see Footnote 1 for other tools assessing multidimensional motivation and engagement). There are three versions of the MES: an elementary school version, high school version, and university/college version. A detailed account of MES psychometrics and construct validity is beyond the scope of this review and so the reader is referred to Liem and Martin (2012) who presented summary statistics from many studies showing that responses to the MES factors are normally distributed, internally consistent, and perform well in lower order and higher order confirmatory factor analysis. In terms of external validity, Liem and Martin (2012) also presented summary statistics showing that MES factors are significantly associated with academic outcomes (e.g., achievement).

### Summary of Integrated Motivation (and Engagement)—and a Clarifying Note

There are numerous major theories that describe and explain academic motivation. Given the multidimensional picture emanating from these theories, there have been calls for integrative approaches to motivation research and theorizing (Murphy & Alexander, 2000; Pintrich, 2003; Reschly & Christenson, 2012; Wong & Liem, 2021). The Motivation and Engagement Wheel was developed as one effort towards an integrative framework aimed at reflecting the multidimensionality of motivation and engagement, the demarcation of motivation and engagement into positive (adaptive) and negative (maladaptive) components, and the collection of specific (lower order) motivation and engagement factors under broader (higher order) dimensions. This represents Step 1a of the hypothesized *intra*-domain integration: unifying multidimensional motivation and engagement. In the following section, attention turns to Step 1b of this hypothesized *intra*-domain integration: unifying explicit instruction and independent learning. Following this is Step 2, *inter*-domain integration of motivation and instruction.

However, before moving to this, an important clarifying note on this review's integrative framework is warranted. The review draws on the Motivation and Engagement Wheel as one example of how various theories may be collected together and organized under parsimonious themes—and then linked to other aspects of academic life, such as instruction (LRI, in the case of present discussion). The Wheel is not intended to be exhaustive, definitive, or prescriptive. Indeed, in justifying the level of parsimony and inclusiveness in the Wheel, it has been recognized there will inevitably be factors that are included in major theories, but not in the Wheel (Martin, 2007; e.g., intrinsic motivation and autonomy in the case of motivation; participation in the case of engagement). The Wheel has also been developed to represent constructs that are predominantly intra-personal. Whilst recognizing and demonstrating the role of socio-cultural contextual factors implicated in motivation (e.g., relatedness), these are constructs that have a more inter-personal aspect to them and thus have been conceptualized as beyond the composition of the Wheel itself (though research clearly demonstrates significant associations between interpersonal factors and Wheel factors, e.g., Martin et al., 2009).

In essence, the Wheel resides within a broader ecology of efforts to unite (or organize) diverse motivation theories and constructs—but it is not the only effort. This being the case, it is appropriate to briefly summarize some recent integrative contributions that provide a sense of how other theorists and researchers are considering and framing this space. In briefly mapping this terrain, the Wheel can be better understood in terms of what it is and what it is not.

Dweck (2017) recently proposed a major unified theory of motivation, personality, and development. Dweck defined motivation as the forces that drive and direct behavior. She specified individuals' basic needs and how individuals build mental representations of their experiences (beliefs, representations of emotions and action tendencies) as they pursue need-fulfilling goals—and which are the basis of motivation and personality (with these processes being mechanisms that can unify motivation and personality). Needs include basic needs such as competence and predictability as well as associated compound needs such as control and self-perceived competence—concepts that have been frequently located in the motivational literature, including the Wheel.

Hattie et al. (2020) identified four major dimensions that are common across motivation models: person factors (comprising self [e.g., self-efficacy], social [e.g., comparisons], and cognitive [e.g., self-regulation] factors); task values; goals; and perceived benefits and costs. In drawing together various reviews of motivation theories, Wigfield and Koenka (2020) identified numerous convergences, including that there are hierarchies of motivational beliefs (not isolated, specific ones) and that there are contextual influences on motivation—which are both reflected in the present review by way of the higher order factors in the Wheel (hierarchies of motivational beliefs) and the role of instruction in student motivation and engagement (contextual influences on motivation).

Anderman's (2020) review of motivation identified overlaps and uniqueness among theories, including the theories addressed in the present discussion (situated expectancy-value theory, self-determination theory, etc.). Anderman explored the idea of whether all these theories were necessary. From a research perspective, Anderman suggested that they probably were as they allowed researchers to design research studies with precision and targeted constructs. However, from a practice and policy perspective, Anderman speculated whether all theories were needed, as they risked being "complex, too detailed, and decontextualized from the daily lives of teachers and students" (p. 4). Anderman noted there were very few attempts to integrate motivation theories and suggested an overarching theory of motivation may be helpful.

It is also evident that factors in the Wheel are aligned with the engagement conceptual landscape. For example, Fredricks et al. (2004; Fredricks & McColskey, 2012) identify engagement as a tripartite meta-construct subsumed by behavioral, cognitive, and emotional engagement. Finn and Zimmer (2012) summarized an overarching engagement concept in terms of behavioral (academic, social, and cognitive) and emotional dimensions. Appleton et al. (2006) and Christenson et al. (2008) identified engagement as subsumed by academic, behavioral, cognitive, and affective dimensions. As noted above, the Wheel represents some of these (cognitive and behavioral, e.g., by way of factors such as self-efficacy and persistence, respectively) relatively explicitly, and others (emotional, e.g., by way of aspects of valuing and anxiety) more implicitly.

Taken together, then, the Motivation and Engagement Wheel is one approach to organizing salient motivation and engagement constructs and adopted for the purposes of the present review that is an illustrative effort towards linking motivation (and engagement) and instruction in a more cohesive and unified way. In line with conclusions drawn in other organizing and integrative reviews (e.g., Anderman, 2020; Dweck, 2017; Hattie et al., 2020; Wigfield & Koenka, 2020), future researchers embarking on unifying themes may well do better and get closer following these illustrative efforts.

## Step 1b: Intra-domain Integration of Explicit Instruction and Independent Learning

### Interface of Individual Student Attributes and the Learning Environment

When seeking to understand and optimize students' motivation, it is vital to do so with due recognition of the learning environments in which motivation is enacted (e.g., Eccles & Wigfield, 2020; Nolen, 2020; Pintrich, 2003). Accordingly, researchers have explored the contextual factors that are implicated in students' motivation, with significant attention given to the role of teacher and classroom factors. These factors include teacher-student relationships (Martin & Collie, 2019; Martin & Dowson, 2009; Reeve, 2012), teacher support and encouragement (Voelkl, 2012), classroom goal structures (Anderman & Patrick, 2012; Pekrun & Linnenbrink-Garcia, 2012), and collective classroom agency (Schunk & Mullen, 2012). In the past decade, cognitive psychology has directed particular attention to the role of teacher instruction in students' learning—suggesting an emphasis on various instructional approaches that seek to optimally accommodate the human memory system (e.g., direct instruction, Engelmann & Carnine, 1991; explicit instruction, Evans & Martin, 2021; cognitive load theory, CLT, Sweller, 2012). More recently, there have been efforts to harmonize major explicit (and related) instructional principles with constructivist instructional approaches—leading to the development of "load reduction instruction" (LRI; Martin, 2016; Martin & Evans, 2018, 2019, 2021). This represents Step 1b of this review that integrates explicit and constructivist approaches—via LRI—to demonstrate how these pedagogical approaches can be implemented in a synergistic way.

## Major Theories and Approaches to Instruction

For many decades, there has been something of an ongoing tussle between positivist (or post-positivist) explicit and direct approaches to instruction and constructivist (or post-modernist) approaches to instruction. Explicit instruction is based on the idea that a direct, structured, and systemic approach to instruction is important, particularly in the early stages of learning. It typically comprises an emphasis on didactic instruction, sequenced learning segments, lots of examples, frequent practice and rehearsal, and relatively less emphasis on autonomous learning (Evans & Martin, 2021). Constructivist approaches to instruction emphasize learning environments that prioritize discovery opportunities, focus on students' construction of meaning, and encourage students to explore and generate concepts for themselves (Pressley et al., 2003). The teacher's role tends to be as facilitator and tends to be less directive and more responsive to students as they autonomously explore concepts and seek to solve problems (Ausubel, 1961; Bruner, 1961; Pressley et al., 2003).

The divergence between explicit and constructivist approaches to instruction is mainly in the amount and type of instruction provided (Evans & Martin, 2021). Constructivism, largely emanating from the work of theorists such as Piaget (1954/2013), Vygotsky (1970) and Bruner (1961), tends to posit that knowledge is situated in the activity of the learner, with an emphasis on the (social and cultural) construction of knowledge through that activity. Typical constructivist approaches include discovery learning, problem-based learning, inquiry learning, experiential learning—each having an underlying commonality in the minimization of top-down teacher direction, leading to what is referred to as 'minimal guidance' instruction (Kirschner et al., 2006).

Because there are numerous divergences between explicit and constructivist approaches, it is not uncommon for these two approaches to be set somewhat in opposition to each other and framed as mutually exclusive (for one review of this debate, see Tobias & Duffy, 2009). As many researchers and educators will know, seeing these two approaches to instruction as mutually exclusive can set in place a false dichotomy. There are synergies and neither approach has exclusive claims to particular instructional strategies. For example, scaffolding is important in both explicit and constructivist instruction approaches (Evans & Martin, 2021) and there are points in the learner's development where minimal guidance (e.g., problem solving) is not incompatible with cognitive learning structures that are implicit in information processing models (Schmidt et al., 2007). It is also evident that the two are intertwined such that the effectiveness of one relies on the effectiveness of the other. As summarized in Liem and Martin (2013): "constructivist approaches are better assisted by direct and structured input from the teacher that systematically and unambiguously builds the knowledge and skills needed to subsequently engage in meaningful discovery, problem-based, and enquiry-based learning" (p. 368). Thus, high quality learning relies on students experiencing both explicit and independent approaches to instruction and learning. This being the case, privileging one over the other risks denying students access to learning opportunities that one approach may afford more than the other. Therefore, integrating the two approaches is important for more comprehensively supporting students' learning.

LRI was developed as one effort towards an integrative response. A key principle in LRI is that alongside explicit instruction, guided independent learning is essential to the learning process. Specifically, after sufficient explicit input from the teacher (or learning resource such as a textbook) there is an important place for guided independent learning (Liem & Martin, 2013, 2020; see also Alfieri et al., 2011; Martin, 2016; Martin & Evans, 2019, 2021; Marzano, 2011). Once learners have moved beyond novice status, they have the requisite knowledge and skill to engage in meaningful independent learning.

## Load Reduction Instruction: An Integrative Response to Major Theories and Approaches to Instruction

CLT identifies two main kinds of cognitive load that can be imposed by teachers on students: intrinsic and extraneous cognitive load (Sweller et al., 2011). Intrinsic cognitive load refers to the inherent difficulty of instructional material and learning activities. Extraneous cognitive load is a function of how instruction and learning activities are presented and structured (Sweller et al., 2011). Extraneous cognitive load is an unnecessary burden on students and does not contribute to learning (Sweller et al., 2011).

Drawing on CLT, LRI identifies instructional principles and practices that are aimed at reducing extraneous cognitive load (as the main yield)—and to some extent, intrinsic cognitive load (as a subsidiary yield) (Martin, 2016; Martin & Evans, 2019, 2021; Martin, Ginns, et al., 2021a, 2021b). A key idea in LRI is the importance of reducing extrinsic and intrinsic cognitive load when students are novices and in the early stages of learning (e.g., commencing a new topic, or subject, etc.). Failure to reduce extrinsic and intrinsic cognitive load risks a failure to learn. However, when students have grasped the requisite knowledge and skill, it is appropriate to introduce guided independent and discovery approaches (Liem & Martin, 2013, 2020; Martin & Evans, 2018, 2019, 2021; Martin et al., 2023; see also Kalyuga et al., 2012). Thus, LRI holds that explicit and constructivist approaches are not only compatible, but fundamentally synergistic—the effectiveness of one is intertwined with the effectiveness of the other (Liem & Martin, 2013, 2020; Martin, 2016; Martin & Evans, 2018, 2019, 2021; Martin, Ginns, et al., 2021a, 2021b).

## The Human Memory System and LRI: Implications for Addressing Gaps in Approaches to Instruction

Cognitive psychology has identified the importance of instructional approaches that seek to account for the limits and opportunities in the human memory system (e.g., Sweller, 2012). Recently, LRI has been advanced to address gaps between explicit instruction and independent learning so that educators can successfully navigate these cognitive limits and opportunities.

### Human Memory

LRI (and CLT) principles rest very much on the architecture of the human memory system and draw on major elements of the information processing model—and in particular, working and long-term memory (Martin, 2016; see also Baddeley, 2012; Evans & Martin, 2021; Kirschner et al., 2006; Sweller, 2012; Winne & Nesbit, 2010). Long-term memory and working memory belong to an information processing model of the memory system referred to as the modal model (as it comprises elements that are in various memory system models; also referred to as the multi-store or Atkinson-Shiffrin model; Atkinson & Shiffrin, 1968). Of major relevance to LRI (and CLT) are the functions of, and links between, working and long-term memory. Working memory is a space for information that individuals are consciously and currently aware of, and where they think and focus attention (Baddeley, 2012; Baddeley & Hitch, 1974). Working memory is limited in capacity and duration (Cowan, 2010; Miller, 1956). Information is lost in a brief period of time unless it is rehearsed, or encoded in long-term memory. To encode in long-term memory, working memory processes new information in relation to information that is already encoded for later retrieval. Long-term memory is a large-scale information store with no known capacity limits. Long-term memory encodes information so that it can be subsequently retrieved and thus constitutes the critical prior learning that is implicated in instructional frameworks such as LRI and CLT.

To summarize as relevant to learning and instruction, working memory receives and processes information in real-time (e.g., performs tasks), including new information. Long-term memory stores information that is successfully processed from working memory. Learning occurs when information is "moved" from working memory and is encoded or represented in long-term memory so it can be successfully retrieved at a later time (Kirschner & Bruyckere, 2017; Kirschner et al., 2006; Martin & Evans, 2018, 2019, 2021; Sweller, 2012; Winne & Nesbit, 2010).

By building up students' long-term memory, they essentially have a greater base of prior learning when embarking on novel learning tasks. Working memory is very limited. Long-term memory has vast capacity (Sweller, 2012). Effective instruction takes into account the limits of students' working memory and helps them transfer information from working memory to be stored or represented in long-term memory (Martin, 2015, 2016; Martin & Evans, 2018, 2019; Paas et al., 2003; Sweller, 2004; Winne & Nesbit, 2010). According to Kirschner and colleagues: "Any instructional theory that ignores the limits of working memory when dealing with novel information or ignores the disappearance of those limits when dealing with familiar information is unlikely to be effective" (2006, p. 77). Thus, one of the most relevant implications of the memory system for instruction is that new information rapidly consumes and potentially overwhelms working memory; however, when information has previously been successfully encoded into long-term memory (i.e., it has been learnt), virtually no working memory resources are consumed.

### LRI Principles

When students develop fluency and automaticity in knowledge and skill (largely through information successfully encoded in long-term memory), they have more working memory available for new tasks or novel information. Fluency and automaticity reduce cognitive burden that in turn helps students accommodate and move novel information into long-term memory (Rosenshine, 2009). This idea is fundamental to LRI. Indeed, its first four (of five) principles are directed to successfully building students' long-term memory, and thus fluency and automaticity, as follows (Martin et al., 2021b):

- Principle #1: Reduce the difficulty of instruction in the initial stages of learning, as appropriate to the learner's level of prior knowledge and skill (see also Mayer & Moreno, 2010; Pollock et al., 2002);
- Principle #2: Provide appropriate support and scaffolding to learn relevant knowledge and skill (see also Renkl, 2014; Renkl & Atkinson, 2010);
- Principle #3: Allow sufficient opportunity for practice (see also Nandagopal & Ericsson, 2012; Purdie & Ellis, 2005; Rosenshine, 2009);
- Principle #4: Provide appropriate feedback-feedforward (combination of corrective information and specific improvement-oriented guidance) as needed (see also Hattie, 2009; Mayer & Moreno, 2010; Shute, 2008).

Through these four principles (also see Fig. 3), information is successfully encoded in long-term memory and both fluency and automaticity are developed (Mayer & Moreno, 2010). In so doing, students have a greater prior learning base. By successfully encoding information into long-term memory (prior learning) for students to retrieve in real-time frees up students' working memory (Baddeley, 2012) so they can now embark on learning material or learning tasks that may have previously imposed too much cognitive load on them. Importantly, this includes novel and complex tasks, as well as activities that involve guided

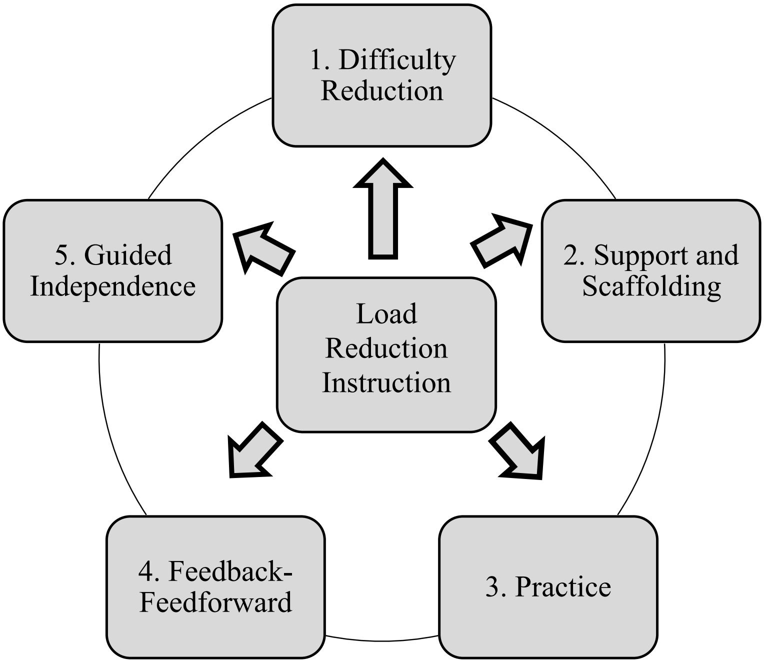


**Fig. 3** Load reduction instruction (LRI) framework—adapted with permission from Martin (2016)

independent and discovery-oriented learning (Martin, 2016; Martin & Evans, 2019). In fact, CLT research demonstrates that when learners have developed sufficient automaticity and fluency in knowledge and skill (i.e., expertise), they do not benefit from approaches that are unnecessarily explicit and structured. Instead, they benefit more from open, problem-solving approaches—referred to as the "expertise reversal effect" (Kalyuga, 2007; Kalyuga et al., 2001, 2003). For example, if learners know how to solve a problem but are still asked to engage in structured practice to enhance automation, this could burden their working memory. Therefore, once students have developed appropriate fluency and automaticity in the requisite knowledge and skill, they are ready for the fifth and final principle of LRI:

- Principle #5: Guided independent learning (see also Mayer, 2004).

Importantly, it is this fifth major principle that represents a fundamental unification of explicit and constructivist instructional approaches—and by implication, bridging gaps in instructional approaches. Specifically, after the teacher has provided sufficient difficulty reduction, instructional support, practice, and feedback-feedforward for students to acquire the necessary knowledge, greater independence can then be afforded to students (Kalyuga et al., 2003). Thus, following the necessary explicit and structured instruction (i.e., LRI principles #1–4; though as noted above, explicit instruction does not have exclusive claims over these elements—e.g.,

**Table 1** LRI Principle #1—difficulty reduction: strategies and examples

LRI Principle #1: Reducing the difficulty of a task during initial learning, as appropriate to prior knowledge and skill

| Strategies | Examples |
|---|---|
| Pre-training | Teacher provides early instruction on the core elements of a task (e.g., identifying name, definition, location, function of topics or components) to assist subsequent learning |
| Modelling Important Processes | Teacher demonstrates how to complete a task; can also involve teacher "think-aloud" strategies as the teacher conducts a task |
| Segmenting | Teacher breaks a task into "bite-size" components (or "chunks") and encourages students to see the completion of each component as a success |
| Preliminary (and Spaced) Reviews | Teacher and students review prior learning at the outset of a new task or lesson; teacher reviews at regular (spaced) intervals (e.g., review prior week's learning at the start of each week) |

Martin (2016, pp. 12–13). Also see Martin (2016) for references supporting theory and research for each strategy

scaffolding is a well-established practice under constructivist approaches), students benefit from relatively greater independence (i.e., LRI principle #5) (Hermkes et al., 2018; Liem & Martin, 2013, 2020; Martin, 2016; Martin & Evans, 2018; Mayer, 2004). To the extent this is the case, learners benefit from explicit (and structured) instruction *and* from guided independent learning. But critically, it is the sequencing of these two that is pivotal to optimize learning: students benefit from predominantly explicit instruction in the early stages of task and content mastery and then are further enriched by immersing in a guided independent phase of learning as the automaticity and fluency of knowledge and skill develop.

## Teaching Strategies to Operationalize LRI

LRI, and the CLT research informing it, provide important direction for articulating specific teaching strategies aimed at appropriately managing the burden on learners as they move from novice to expert status. Martin (2016, pp. 12–14) mapped each of the five LRI principles and seminal corresponding CLT effects against examples of teaching strategies that can be used to operationalize the key tenets of LRI and CLT. These are detailed in Table 1 (LRI principle #1: reducing the difficulty of a task during initial learning as appropriate to the learner's prior knowledge and skill), Table 2 (LRI principle #2: instructional support and scaffolding), Table 3 (LRI principle #3: ample structured practice), Table 4 (LRI principle #4: provision of instructional feedback-feedforward), and Table 5 (LRI principle #5: guided independent learning). Given limitations of space, all of these will not be described here (see Martin, 2016 for a full account), but some will be summarized in the section below that integrates motivation and instruction.

**Table 2** LRI Principle #2—support and scaffolding: strategies and examples

| LRI Principle #2: Instructional support and scaffolding through the task | |
|---|---|
| Strategies | Examples |
| Reducing Split-attention | Two or more stimuli are integrated where feasible to reduce splitting students' attention across disparate stimuli (e.g., integrate the equation for finding an angle into the angle itself on a given diagram) |
| Integrating | Teacher integrates the focus of a learning task with a meaningful problem (e.g., integrate instruction on punctuation into a student's own essay) |
| Information Integration Sequencing | Teacher integrates two successive pieces of instructional material into the one instructional element (e.g., integrate the narration of how lightening is formed with an animation of that process) |
| Harnessing Different Modalities | Teacher presents different pieces of information (or stimuli) in a different modality (e.g., present an image with a narrative in order to reduce the burden on visual and auditory processers) |
| Avoiding Redundancy and Increasing Coherence | Where appropriate, teacher presents information once (avoiding redundancy) and organizes material so that extraneous or overly elaborate material that may be tangential to essential learning is reduced or removed (increasing coherence) |
| Signaling | Teacher provides cues to help the learner locate and focus on the essential material in a lesson or activity (e.g., teacher asks students to watch out for a particular event or character in a plot) |
| Organizing Information Thematically | Teacher identifies a major/main theme in a task or learning activity and explicitly connects instruction to this theme |
| Allowing Appropriate Instructional Time | Teacher schedules tasks and lessons to ensure sufficient instructional time occurs in a task, in a lesson, and across the day |
| Checking for Understanding | Teacher employs checking strategies such as frequently posing questions and asking students to summarize major points or repeat explanations |
| Worked Examples | New material is presented to learners with completed samples of work that show how a particular problem can be solved or task is to be completed |
| Providing Templates | Materials are provided to learners that are formatted or structured to help the learner stay on track or that list the important features to include or address in a task |
| Prompting | Learners are strategically prompted to persist with and complete less structured tasks such as those found in comprehension and writing tasks (e.g., students are asked to identify the "what", "who", "why", and "when" in a stimulus passage; this helps them extract specific information or articulate an answer or response) |
| Personalizing | Teacher adjusts wording and/or administration of a task to involve the learner in a more personalized and individually-relevant way (e.g., use instructions such as "Your goal in this task is to …" rather than "The goal for this task is to …") |

Martin (2016, pp. 13–14). Also see Martin (2016) for references supporting theory and research for each strategy

**Table 3** LRI Principle #3—practice: strategies and examples

| LRI Principle #3: Ample structured practice | |
|---|---|
| Strategies | Examples |
| Deliberate Practice | Teacher ensures rehearsal that is relevant to a specific skill, usually also involving feedback, and conducted by the student on their own |
| Mental Practice | Learners imagine or mentally rehearse a concept or procedure (e.g., the student studies an example, then turns away and rehearses the example in their mind) |
| Guided Practice | Learners are systematically guided through the steps of learning or problem solving (e.g., prompting responses through a task or providing part of a solution for a student to complete) |

Martin (2016, p. 14). Also see Martin (2016) for references supporting theory and research for each strategy

## Summary of Load Reduction Instruction

Explicit instruction is advocated as a means to manage the cognitive burden on the novice student in order to optimize their learning. Independent (and related discovery) learning is advocated as a way to allow the student to problem solve and learn in self-directed ways. It can be easy to simplistically frame them in mutually exclusive terms, but in fact they can be harmonized in effective ways and indeed, one does not have exclusive claims on pedagogical approaches over the other (e.g., scaffolding can be accommodated under constructivist approaches and minimal guidance under CLT; Hermkes et al., 2018; Kalyuga, 2007; Schmidt et al., 2007). LRI has been developed to operationalize this synthesis so the student can benefit from the strengths each instructional approach offers in the learning space. This represents Step 1b of the present *intra*-domain integration: unifying explicit instruction and independent learning. Attention now turns to Step 2 that is the hypothesized *inter*-domain integration: unifying motivation (and engagement) and instruction.

**Table 4** LRI Principle #4—feedback-feedforward: strategies and examples

| LRI Principle #4: Appropriate provision of instructional feedback-feedforward | |
|---|---|
| Strategies | Examples |
| Showcasing | In instances of misunderstanding or poor learning progress, teacher provides examples of good practices and good work to give clarity on what constitutes good work and how to do it |
| Feedback | Concrete and specific information is provided on the correctness of an answer or the quality of application |
| Feedforward | Concrete and specific information is provided on how the answer or quality of the application can be improved |

Martin (2016, p. 14). Also see Martin (2016) for references supporting theory and research for each strategy

**Table 5** LRI Principle #5—guided independence: strategies and examples

| LRI Principle #5: Guided independent learning | |
|---|---|
| Strategies | Examples |
| Guided Independent Practice | When knowledge and skill become automated and fluent, the learner is encouraged and appropriately supported to attempt similar problem tasks independently |
| Guided Discovery Learning | When the learner has engaged in successful independent practice, they are encouraged and appropriately supported to undertake new tasks, move in new directions, or apply learning to "real-world" problems that further enrich learning |

Martin (2016, p. 14). Also see Martin (2016) for references supporting theory and research for each strategy

## Step 2: Inter-Domain Integration of Motivation and Instruction

### LRI, Motivation, and Engagement

Martin (2021) described how the five LRI principles are key to students' personal investment (e.g., motivation) in learning. In that review, it was explained how motivation and engagement are optimized when there is pedagogical structure in place (i.e., when teachers provide explicit plans for the lesson, clear directions, feedback, and guidance, e.g., Jang et al., 2010; Sierens et al., 2009). He also argued that when teachers ease the difficulty of tasks to match the level of students' prior knowledge, students are less inclined to disengage from their schoolwork (Ashcraft & Kirk, 2001; Martin, 2016). Thus, LRI principles are implicated in the adaptive and maladaptive dimensions of students' motivation and engagement. In this review, this idea is extended to also consider the role of student motivation and engagement in teachers' application of LRI. It is this cyclical relationship that is, arguably, the most authentic form of inter-domain integration. Certainly, a theoretically-based unidirectional process from instruction to motivation and engagement is support for inter-domain integration. However, the extent to which motivation and engagement in turn impact LRI reflects deep inter-domain integration and authentically signals that the effectiveness of one is indeed tied to the effectiveness of the other.

### The Validity of Hypothesized Links Between LRI and Student Motivation and Engagement

Based on data collected using the Load Reduction Instruction Scale (Martin & Evans, 2018), empirical validity support was provided for the role of LRI in students' motivation and engagement (further below, the role of motivation and engagement in LRI is discussed). The Load Reduction Instruction Scale (LRIS; validated by way of multilevel CFA and multilevel reliability, Martin & Evans, 2018; Martin, Ginns, et al., 2021a, 2021b) comprises five factors, in line with the five principles of LRI. Students report on their teacher's instruction on each of the five LRI principles. Martin and Evans (2018) found that the LRIS was significantly and positively associated with positive motivation and engagement factors in the Wheel and significantly and inversely associated with the Wheel's negative motivation and engagement factors. In a longitudinal study of multi-level motivation, engagement, and achievement in mathematics, Evans and Martin (2022) found empirical support for the link between LRI and academic motivation (the positive motivation dimensions of the Wheel) and also demonstrated a link between classroom-level LRI and classroom-level motivation. In a person-centered study Martin, Ginns, et al. (2021a) used latent profile analysis to identify the various instructional-psychological profiles emerging from students' reports of instructional load (using the LRIS) and their accompanying psychological challenge and threat orientations (operationalized via the Wheel's self-efficacy, anxiety, and failure avoidance factors). They identified five instructional-motivational profiles that represented different presentations of instructional cognitive load, challenge orientation (self-efficacy), and threat orientation (anxiety and failure avoidance). In turn, these profiles were statistically separated in terms of their effects on academic achievement. LRI research has also identified links with other engagement factors that are outside the Wheel, but cognate in terms of their cognitive and behavioral dimensions. For example, the Evans and Martin (2022) study of mathematics classrooms included tripartite engagement (Fredricks et al., 2004) and found student- and classroom-average links between LRI and engagement. In science, Martin et al. (2021b) conducted a multilevel study of the LRIS in more than 180 science classrooms. They found that tripartite engagement mediated the link between the LRIS and achievement (at student- and classroom-levels). In mathematics and English classrooms, Martin et al. (2023) found LRI significantly predictive of students' effort at student- and classroom-levels. There are thus empirical links between LRI and students' motivation and engagement (including motivation and engagement factors in the Wheel) that provide one line of evidence supporting the validity of the hypothesized nexus between instruction and motivation and engagement.

## Representing Inter-domain Integration of Motivation and Instruction

As signaled above, a deep and authentic inter-domain integration would be such that instruction impacts motivation (and engagement) that in turn impacts subsequent instruction (and so on). This idea is in line with some of the more recent integrative reviews of motivation theorizing. Nolen (2020), for example, delineated the situated aspects of motivation in terms of individuals' multiple and overlapping systems of meaning, whose worlds "are created by the activity of people interacting with each other and the material world over historical time and include practices, roles, values, discourses, and tools that both become characteristic of and continue to be developed through activity" (p. 1). Teachers and students are not independent; teachers affect students, students affect teachers, and the nature of these links shift over time. The present review attends to this idea from an instruction-motivation perspective, but research has shown this to be the case in cognate aspects of classroom life (e.g., teacher-student relationships and motivation; Skinner & Belmont, 1993).

Martin (2016) developed a schematic to represent the integration of the Wheel and LRI (and related approaches such as CLT). It is reproduced in Fig. 4. It is suggested that the motivation-instruction nexus is developed and enriched through mutual and cyclical influences (as shown in the central part of Fig. 1). Taking self-efficacy (one part of the Wheel) as a case in point: students' task-specific self-confidence is enhanced through the academic knowledge and skill that LRI strategies help students to acquire; in turn, students who are self-efficacious are more likely to generate alternative courses of action if they do not succeed, invest greater effort at any given point in time, and adapt better to challenging task demands (Bandura, 1997, 2001)—leading to enhanced academic knowledge and skill that in turn undergirds their subsequent self-efficacy (Marsh, 2007; Marsh & Martin, 2011; Schunk & Miller, 2002).

Extending this inter-domain nexus further, when students develop their skill and knowledge as a function of their efficacious self-beliefs and behavior (Bandura, 1997, 2001), the application of LRI also develops. The level of difficulty (principle #1) is adjusted to students' elevated level of competence. The nature and level of support and scaffolding (principle #2) is adjusted as students master more of the requisite knowledge and skill. The nature of practice (principle #3) can change from fully worked examples to partially worked examples. The type of feedback-feedforward (principle #4) can change to more advanced improvement-oriented guidance (and perhaps less corrective information). Finally, through the escalation of competence as a function of more efficacious self-beliefs and behaviors and the elevation of instruction in LRI principles #1-#4, the teacher is in a strong position to increasingly emphasize independent application (principle #5) as the students more autonomously apply the now fluent and automated knowledge and skill (that has been encoded in long-term memory).

Preliminary support for the motivation→instruction link in LRI research was suggested in a recent study by Martin and colleagues (2023). They found that teachers' self-reports of LRI differed as a function of class-average prior learning such that teachers engaged in difficulty reduction when prior learning was low. Given that motivation and engagement are closely implicated in learning (e.g., Howard et al., 2021; Jones & Carter, 2019), it may be speculated that low levels of student motivation and engagement were also implicated in teachers' rationale to reduce difficulty in classrooms where students struggled with learning. To the extent this is the case, prior levels of student motivation and engagement may be related to teachers' subsequent application of LRI. Further research is needed to confirm this suggestion.

All this being the case, we return to the fundamental concept underpinning the hypothesized *inter*-domain integration: the success of one domain (e.g., motivation and engagement) is tied to the success of the other (e.g., instruction). Motivation and engagement are thus optimized by the presence of high-quality instruction and instruction is optimized by the presence of motivated and engaged students (see Fig. 1).

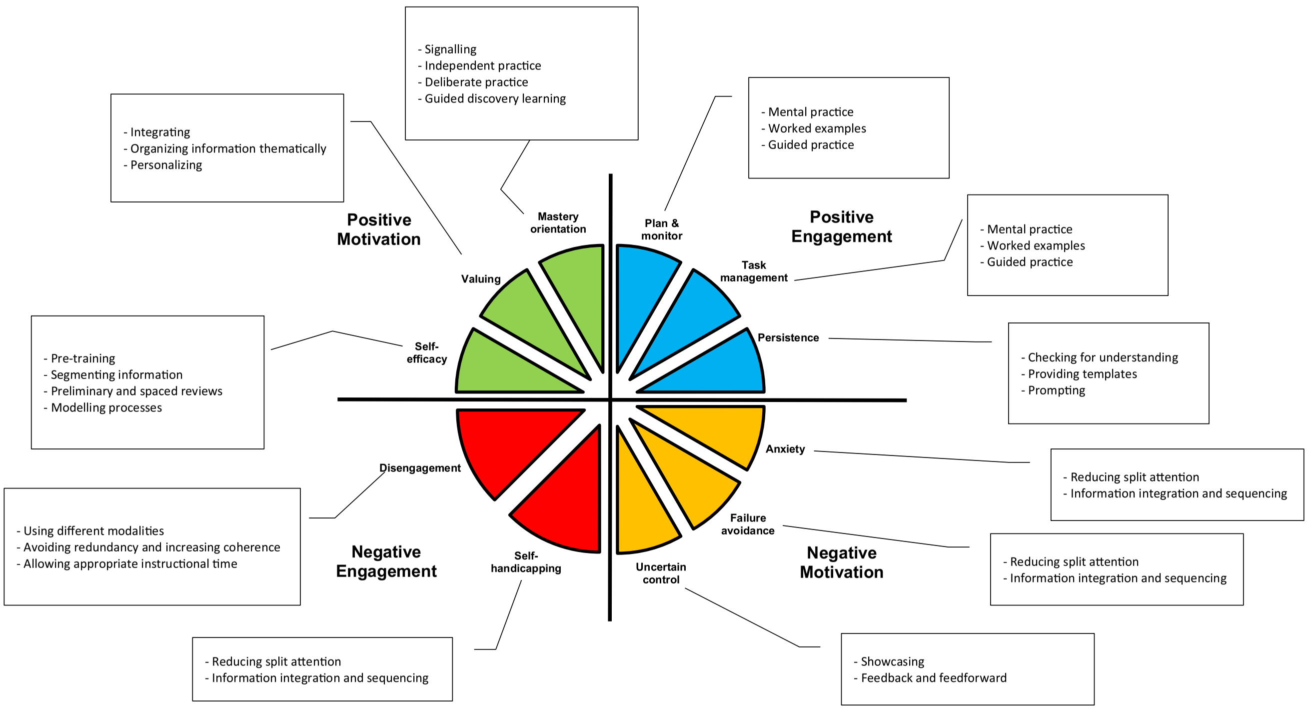


**Fig. 4** The Motivation and Engagement Wheel integrated with explicit instruction (LRI and CLT) elements. See Tables 1, 2, 3, 4 and 5 for descriptions of each strategy and nesting under LRI. Reproduced with permission from Martin (2016, p. 37)

### The Motivation-Instruction Synthesis in Practice

It is also helpful to consider the motivation-instruction synthesis from an applied perspective. CLT and LRI have identified many instructional practices that are key to managing the cognitive burden on students as they learn. With a view to integrating instructional and motivational psychology, Martin (2016, 2021) mapped these CLT and LRI practices against specific parts of the Motivation and Engagement Wheel. The reader is referred to those reviews for a complete coverage (see also Tables 1, 2, 3, 4 and 5), but for the present discussion a selection of explicit instructional strategies (mental practice, worked examples, checking for understanding, templates, reducing split attention, using different modalities, reducing redundancy) are cross-referenced with key parts of the Motivation and Engagement Wheel (planning and monitoring, task management, persistence, anxiety, disengagement).

*Planning (and Monitoring) and Task Management.* Mental practice and worked examples are relevant to students' planning, monitoring, and task management. *Mental practice* (Sweller, 2012) involves learners mentally rehearsing a procedure or concept, with planning and monitoring benefiting from learners mentally representing important parts of a task or schedule of activities (Martin, 2010, 2016). *Worked examples* are completed work samples that demonstrate how a task can be completed (Atkinson et al., 2000; Renkle, 2014; Renkl & Atkinson, 2010; Rosenshine, 1995, 2009; Sweller, 2012). They identify the parts of a task needed to plan, clarify components that are important to monitor, that together assist learners' task management.

*Persistence.* Persistence is assisted when students understand what they are required to do and when students are scaffolded through the learning process. Instructional strategies that facilitate these include teachers checking for understanding and using templates (Martin, 2021). *Checking for student understanding* can involve "rapid formative assessment" (Wiliam, 2011) so that students have sufficient knowledge to remain on task and maintain persistence through the task—and for teachers to provide targeted in-time assistance as needed. Another way to keep students on track and persisting is to use *templates*. These may be structured, comprising a checklist that scaffolds a student through a task or "process worksheets" that explicitly identify the steps involved in persisting to task completion (Van Merriënboer, 1992).

*Anxiety.* Anxiety can be elevated to an unhelpful level when excessive cognitive burden is experienced (Chadwick et al., 2015; Martin, Ginns, et al., 2021a)—note, however, there are times when anxiety can be arousing more than threatening (Martin, Kennett, et al., 2021a, 2021b, 2021c) and that cognitive burden appropriate to the student's prior learning may evince adaptive arousal, not maladaptive anxiety (Martin, Ginns, et al., 2021a). In the discussion above, numerous factors (mental practice, worked examples, etc.) are helpful for reducing cognitive burden. Martin (2016, 2021) suggested additional approaches to reducing instructional cognitive burden as relevant to students' anxiety, including reducing split attention. Split attention occurs when information to solve a problem is presented in different parts of the learning space—such as in different parts of a screen or page (Ginns, 2006; Mayer & Moreno, 2010; Sweller, 2012). This can impose unnecessary cognitive burden and elevate anxiety. *Reducing split attention* involves integrating different informational spaces into one space—e.g., drawing the equation for finding an angle into the angle itself (Sweller, 2012).

*Disengagement.* Poor instructional practices such as inappropriate repetition, unnecessarily complex learning material, and exceeding the capacities of cognitive resources such as visual and auditory processors impose unnecessary cognitive load (Sweller, 2012) and may cause students to switch off (Martin, 2016, 2021). *Using different modalities* involves offloading some of the information from one processor to another (Mayer & Moreno, 2010; Sweller, 2012). Rather than presenting too much visual information to the learner (e.g., via a diagram, text, a table, call-out boxes), which can overload the learner's visual processor, teachers may provide some of the information via the auditory processor such as an audible narrative (Mayer & Moreno, 2010; Sweller, 2012). Unnecessarily presenting the same information twice makes it difficult for the learner to reconcile the two sources of information, places unnecessary burden on the capacity of working memory, and may lead to the student tuning out (Martin, 2016, 2021; Mayer & Moreno, 2010). *Reducing redundancy* can also help here and involves presenting only the essential information (Mayer & Moreno, 2010) and reduces students' disengagement that would arise through them being cognitively overwhelmed (Martin, 2016).

## Boundary Conditions of Integrative Motivation and Instruction Frameworks

The present review has sought to articulate one illustrative effort towards *intra*- and *inter*-domain integration in the motivation (and engagement) and instruction space. As an illustrative articulation was the intent of the review, there has been something of an uncritical tilt to these integrative efforts. In reality, such integrative efforts are not a panacea for addressing the theoretical, empirical, and applied complexities and gaps that plague the fields of motivation, engagement, and instruction. Inevitably, they can present their own limitations and boundary conditions. Noting all such limitations is beyond the scope of the present review, but some indicative ones are briefly discussed to provide a sense of the sorts of issues researchers and practitioners will need to navigate as they seek to adopt and build on this and other integrative frameworks (e.g., see Martin, 2016 for a more extended note of caution regarding LRI and motivation).

Turning to motivation and engagement first, although the Motivation and Engagement Wheel seeks to integrate key factors under salient motivational theories and frameworks, this very integration presents its own gaps and limitations. These include, *inter alia*, "sins of omission" where some motivation factors are excluded from a given model but represented in other models (e.g., see Appleton et al., 2006; McInerney et al., 2001; Midgley et al., 1997; Pintrich et al., 1991; for other validated multidimensional motivation frameworks/instruments)—thus, attending to differentiation as much as integration; representation of key parts of several theories but not comprehensive representation of any one theory; "jingle-jangle" risks that can further confuse the field (Reschly & Christenson, 2012); and separation of hypothetical constructs (e.g., motivation vs engagement) that in practice may be more convergent than a model (including the Wheel) may imply.

Regarding the integrative efforts under LRI, one cautionary note is on its principle #5 (guided independent learning). Researchers have made an important distinction between pure and guided independence (discovery). Pure independence has little teacher input and direction; students are encouraged to independently discover ideas and explore issues for themselves (Pressley et al., 2003). Guided independence comprises some teacher monitoring, input and direction, guiding questions and comments, assistance if needed, and some in-built scaffolds to help the student proceed through the learning task (Martin, 2015; Pressley et al., 2003). By providing guidance, there is less load on students' working memory. Whereas, if there is not sufficient guidance from the teacher, then working memory can be unnecessarily burdened and this can lead to misinterpretation, confusion, or poor learning—suggesting pure discovery as a boundary condition to learning (Mayer, 2004). This being the case, LRI principle #5 emphasizes *guided* independent learning.

It is also important to recognize that LRI is an instructional framework that is about moving a learner from novice status to expert status. LRI is thus not a framework for expert learners per se. Looking at LRI principles #1–5, it is evident that they all speak to the developing learner more than to the expert learner. The first four principles are quite clearly directed to the developing (novice) learner—and even the final principle emphasizes the guided aspect of independent application by the learner. How a teacher instructionally engages with the expert learner is largely beyond the scope of LRI. Perhaps this is the point when independent application moves from guided to solely independent application, such as from guided to pure discovery learning. That said, however, if the teacher seeks to introduce more advanced and/or novel concepts and tasks to the expert learner, then the expert learner may no longer be so expert and LRI enters the instructional frame again.

Another cautionary note on LRI is in relation to low and high performing learners. According to Adams and Engelmann (1996), there are relatively few mistakes among low performers that high performers are not at risk of making (though this may vary as a function of the task, the age of the student, and perhaps the subject domain). Instead, much of the variation seems to be in the degree and amount of a particular instructional approach that is appropriate for low and high performers: "Work with students of different abilities reveals that higher performers require less repetition, fewer examples, and often less reinforcement than lower performers. Lower performers may have concept and skill deficiencies that the higher performers of the same age do not have, and these deficiencies require time to remedy" (Adams & Engelmann, 1996, p. 28). Hence, high ability students do still require attention to LRI principles #1 to #4. This is a point that can sometimes be ignored or underestimated by educators—leading to underperformance by high ability students (Martin, 2016). The vital instructional variation is often in the degree of early difficulty, the pace, or the relative weight given to the core steps prior to moving on to LRI principle #5, guided independent learning.

There is also caution, nuance, and judgement recommended in how the various strategies in Fig. 4 (integration of the Wheel and specific LRI/CLT strategies) are implemented in practice. Even though conceptual integration may be feasible, this does not obviate the possibility of practical conundrums, challenges, and boundary conditions. When applying Fig. 4, Martin (2016) made the point that the assignment of each strategy to each part of the Wheel is not intended to be prescriptive; rather, it is indicative of what specific LRI/CLT strategies can be considered for different parts of motivation and engagement. For example, Fig. 4 strategies identified to address uncertain control (e.g., showcasing and feedback-feedforward) may also be successful in boosting students' persistence and self-efficacy. Also, not all specific LRI/CLT strategies need to be in the one lesson. Marzano (2003) suggests distributing various strategies across a learning unit (not all in one lesson). For example, across a learning unit, early lessons would benefit from pre-training, modeling, templates, worked examples and deliberate practice; then, subsequent lessons would benefit more from independent practice and guided discovery learning.

## Conclusion

Motivation, engagement, and instruction have substantial presence in educational psychology (Jansen et al., 2022). Theory and research within each of these domains tends to be fragmented—and there is even less integration and harmonization between the domains. This presents challenges for researchers and practitioners seeking to implement parsimonious and cohesive approaches to help students learn (Pintrich, 2003). This review has outlined an effort towards a two-step integration process to assist research and practice: *intra*-domain integration (within each of motivation and instruction; Step 1a and Step 1b respectively) and *inter*-domain integration (between motivation and instruction; Step 2). The review has also identified points of convergence and divergence to underpin a synthesis that led to the development of the Wheel, LRI, and their integration; elucidated the joint roles of individual student attributes (motivation) and learning environment (teacher, instruction) in unifying motivation and instruction; addressed complementary gaps and harmonized competing ideas in the course of *intra*- and *inter*-domain integration; summarized some of the empirical support undergirding the feasibility of the frameworks; and, identified boundary conditions to observe as the integrative frameworks are applied in practice and developed further by others.

To conclude, with respect to motivation and engagement, the Motivation and Engagement Wheel (Martin, 2007) is one example of progress towards *intra*-domain integration of key facets of motivation and engagement. With respect to instruction, Load Reduction Instruction (LRI; Martin, 2016; Martin & Evans, 2018, 2021) is an example of progress towards *intra*-domain integration of explicit and constructivist teaching. With respect to educational psychology more broadly, *inter*-domain integration of motivation, engagement, and instruction identifies how motivation and engagement are implicated in LRI, and how LRI is implicated in motivation and engagement. It is concluded that the joint operation of *intra*- and *inter*-domain integration of motivation, engagement, and instruction within educational psychology holds potential for more coherent theorizing, measurement, and application by researchers and practitioners alike.

**Funding** Open Access funding enabled and organized by CAUL and its Member Institutions

## Declarations

**Conflict of Interest** One of the measures (the Motivation and Engagement Scale) cited in this review is a published instrument attracting a fee, part of which is put towards its ongoing development and administration, part of which is donated to UNICEF, and part of which is received by the author as a royalty. However, for this review, there was no fee and no royalty involved.



## References

Adams, G., & Engelmann, S. (1996). *Research on Direct Instruction: 25 years beyond DISTAR*. Educational Achievement Systems.

Ainley, M. (2012). Students' interest and engagement in classroom activities. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (p. 283–302). Springer. https://doi.org/10.1007/978-1-4614-2018-7_13

Alfieri, L., Brooks, P. J., Aldrich, N. J., & Tenenbaum, H. R. (2011). Does discovery-based instruction enhance learning? *Journal of Educational Psychology, 103*, 1–18.

Anderman, E.M. (2020). Achievement motivation theory: Balancing precision and utility. *Contemporary Educational Psychology*, *61*, 101864. https://doi.org/10.1016/j.cedpsych.2020.101864

Anderman, E.M., & Patrick, H. (2012). Achievement goal theory, conceptualization of ability/intelligence, and classroom climate. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.). *Handbook of research on student engagement* (pp. 173–192). Springer. https://doi.org/10.1007/978-1-4614-2018-7_8

Appleton, J. J., Christenson, S. L., Kim, D., & Reschly, A. L. (2006). Measuring cognitive and psychological engagement: Validation of the Student Engagement Instrument. *Journal of School Psychology, 44*, 427–445. https://doi.org/10.1016/j.jsp.2006.04.002

Ashcraft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General, 130*, 224–237. https://doi.org/10.1037/0096-3445.130.2.224

Atkinson, J. W. (Ed.). (1958). *Motives in fantasy, action, and society: A method of assessment and study.* Van Nostrand.

Atkinson, R.C., & Shiffrin, R.M. (1968). Human memory: A proposed system and its control processes. In K.W. Spence & J.T. Spence (Eds). *The psychology of learning and motivation* (Volume 2) (pp. 89–195). Academic Press. https://doi.org/10.1016/S0079-7421(08)60422-3

Atkinson, R. K., Derry, S. J., Renkl, A., & Wortham, D. (2000). Learning from examples: Instructional principles from the worked examples research. *Review of Educational Research, 70*, 181–214. https://doi.org/10.3102/00346543070002181

Ausubel, D. P. (1961). Learning by discovery: Rationale and mystique. *Bulletin of the National Association of Secondary School Principals, 45*, 18–58. https://doi.org/10.1177/019263656104526904

Baddeley, A. D. (2012). Working Memory: Theories, models, and controversies. *Annual Review of Psychology, 63*, 1–29. https://doi.org/10.1146/annurev-psych-120710-100422

Baddeley, A. D., & Hitch, G. (1974). Working memory. *Psychology of Learning and Motivation, 8*, 47–89. https://doi.org/10.1016/S0079-7421(08)60452-1

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Freeman & Co.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology, 52*, 1–26. https://doi.org/10.1146/annurev.psych.52.1.1

Bruner, J. S. (1961). The act of discovery. *Harvard Educational Review, 31*, 21–32.

Chadwick, D., Tindall-Ford, S., Agostinho, S. & Paas, F. (2015). *Using cognitive load compliant instructions to support working memory for anxious students.* 8th Cognitive Load Theory Conference: CO, USA.

Christenson, S.L., Reschly, A.L., Appleton, J.J., Berman, S., Spanjers, D., & Varro, P. (2008). Best practices in fostering student engagement. In A. Thomas & J. Grimes (Eds.), *Best practices in school psychology* (5th ed.). National Association of School Psychologists.

Christenson, S., Reschly, A., & Wylie, C. (Eds.) (2012). *Handbook of research on student engagement*. Springer. https://doi.org/10.1007/978-1-4614-2018-7

Collie, R. J., Martin, A. J., Malmberg, L.-E., Hall, J., & Ginns, P. (2015). Academic buoyancy, student achievement, and the linking role of control: A cross-lagged analysis of high school students. *British Journal of Educational Psychology, 85*, 113–130. https://doi.org/10.1111/bjep.12066

Covington, M. V. (2000). Goal theory, motivation, and school achievement: An integrative review. *Annual Review of Psychology, 51*, 171–200.

Cowan, N. (2010). The magical mystery four: How is working memory capacity limited, and why? *Current Directions in Psychological Science, 19*(1), 51–57. https://doi.org/10.1177/0963721409359277

Cromley, J. G., & Byrnes, J. P. (2012). Instruction and cognition. *Cognitive Science, 3*, 545–553. https://doi.org/10.1002/wcs.1192

De Castella, K., Byrne, D., & Covington, M. (2013). Unmotivated or motivated to fail? A cross-cultural study of achievement motivation, fear of failure, and student disengagement. *Journal of Educational Psychology, 105*(3), 861–880. https://doi.org/10.1037/a0032464

Dean, D., Jr., & Kuhn, D. (2007). Direct instruction vs. discovery: The long view. *Science Education, 91*(3), 384–397.

Deci, E. L., & Ryan, R. M. (2012). Motivation, personality, and development within embedded social contexts: An overview of self-determination theory. In R. M. Ryan (Ed.), *The Oxford handbook of human motivation* (pp. 85–110). Oxford University Press.

Dweck, C. S. (2017). From needs to goals and representations: Foundations for a unified theory of motivation, personality, and development. *Psychological Review, 124*(6), 689–719. https://doi.org/10.1037/rev0000082

Eccles, J. S., & Wigfield, A. (2020). From expectancy-value theory to situated expectancy-value theory: A developmental, social cognitive, and sociocultural perspective on motivation. *Contemporary Educational Psychology, 61*, 101859. https://doi.org/10.1016/j.cedpsych.2020.101859

Elliot, A. J. (2005). A conceptual history of the achievement goal construct. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 52–72). Guildford.

Engelmann, S., & Carnine, D. (1991). *Theory of instruction: Principles and applications* (Rev). ADI Press.

Evans, P., & Martin, A. J. (2021). Explicit instruction. In J. Reeve (Ed.), *Oxford Handbook of Educational Psychology.* Routledge.

Evans, P., & Martin, A. J. (2022). *Load reduction instruction: Multilevel effects for motivation, engagement, and achievement in mathematics*. Submitted for publication.

Finn, J.D., & Zimmer, K.S. (2012). Student engagement: What is it? Why does it matter? In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (p. 97–131). Springer. https://doi.org/10.1007/978-1-4614-2018-7_5

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*, 59–109. https://doi.org/10.3102/00346543074001059

Fredricks, J.A., & McColskey, W. (2012). The measurement of student engagement: A comparative analysis of various methods and student self-report instruments. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 763–782). Springer. https://doi.org/10.1007/978-1-4614-2018-7_37

Ginns, P. (2006). Integrating information: A meta-analysis of the spatial contiguity and temporal contiguity effects. *Learning and Instruction, 16*, 511–525. https://doi.org/10.1016/j.learninstruc.2006.10.001

Graham, S. (2020). An attributional theory of motivation. *Contemporary Educational Psychology, 61*, 101861. https://doi.org/10.1016/j.cedpsych.2020.101861

Harter, S. (1999). *The construction of the self: A developmental perspective*. Guilford Press.
Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Routledge.
Hattie, J., Hodis, F. A., & Kang, S. H. (2020). Theories of motivation: Integration and ways forward. *Contemporary Educational Psychology, 61*, 101865. https://doi.org/10.1016/j.cedpsych.2020.101865
Hermkes, R., Mach, H., & Minnameier, G. (2018). Interaction-based coding of scaffolding processes. *Learning and Instruction, 54*, 147–155. https://doi.org/10.1016/j.learninstruc.2017.09.003
Howard, J. L., Bureau, J., Guay, F., Chong, J. X., & Ryan, R. M. (2021). Student motivation and associated outcomes: A meta-analysis from self-determination theory. *Perspectives on Psychological Science, 16*(6), 1300–1323.
Jang, H., Reeve, J., & Deci, E. L. (2010). Engaging students in learning activities: It is not autonomy support or structure but autonomy support and structure. *Journal of Educational Psychology, 102*(3), 588–600. https://doi.org/10.1037/a0019682
Jansen, T., Meyer, J., Wigfield, A., & Möller, J. (2022). Which student and instructional variables are most strongly related to academic motivation in K-12 education? A systematic review of meta-analyses. *Psychological Bulletin, 148*(1–2), 1–26. https://doi.org/10.1037/bul0000354
Jones, B. D., & Carter, D. (2019). Relationships between students' course perceptions, engagement, and learning. *Social Psychology of Education, 22*(4), 819–839.
Kalyuga, S. (2007). Expertise reversal effect and its implications for learner-tailored instruction. *Educational Psychology Review, 19*, 509–539. https://doi.org/10.1007/s10648-007-9054-3
Kalyuga, S., Chandler, P., Tuovinen, J., & Sweller, J. (2001). When problem solving is superior to studying worked examples. *Journal of Educational Psychology, 93*, 579–588. https://doi.org/10.1037/0022-0663.93.3.579
Kalyuga, S., Ayres, P., Chandler, P., & Sweller, J. (2003). The expertise reversal effect. *Educational Psychologist, 38*, 23–31. https://doi.org/10.1207/S15326985EP3801_4
Kalyuga, S., Rikers, R., & Paas, F. (2012). Educational implications of expertise reversal effects in learning and performance of complex cognitive and sensorimotor skills. *Educational Psychology Review, 24*(2), 313–337. https://doi.org/10.1007/s10648-012-9195-x
Kirschner, P. A., & De Bruyckere, P. (2017). The myths of the digital native and the multitasker. *Teaching and Teacher Education, 67*, 135–142. https://doi.org/10.1016/j.tate.2017.06.001
Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational psychologist, 41*(2), 75–86.
Klahr, D. (2009). "To every thing there is a season, and a time to every purpose under the heavens": What about direct instruction? In S. Tobias & T. M. Duffy (Eds.), *Constructivist instruction: Success or failure?* (pp. 291–310). Routledge/Taylor & Francis Group.
Kuhlthau, C. C., Maniotes, L. K., & Caspari, A. K. (2015). *Guided inquiry: Learning in the 21st century*. Abc-Clio.
Lee, H. S., & Anderson, J. R. (2013). Student learning: What has instruction got to do with it? *Annual Review of Psychology, 64*, 445–469.
Liem, G. A. D., & Martin, A. J. (2012). The Motivation and Engagement Scale: Theoretical framework, psychometric properties, and applied yields. *Australian Psychologist, 47*, 3–13. https://doi.org/10.1111/j.1742-9544.2011.00049.x
Liem, G. A. D., & Martin, A. J. (2013). Direct instruction and academic achievement. In J. Hattie & E. Anderman (Eds.), *International guide to student achievement.* Routledge.
Liem, G. A. D., & Martin, A. J. (2020). Direct instruction. In J. Hattie & E. Anderman (Eds.), *Visible learning: Guide to student achievement.* Routledge.
Lin, X. (2019). Achievement goal orientations as predictors of self-regulated learning strategies of international ESL students. *International Journal of Teaching and Learning in Higher Education, 31*(2), 214–223.
Marsh, H. W. (2007). *Self-concept theory, measurement and research into practice*. British Psychological Society.
Marsh, H. W., & Martin, A. J. (2011). Academic self-concept and academic achievement: Relations and causal ordering. *British Journal of Educational Psychology, 81*, 59–77. https://doi.org/10.1348/000709910X503501
Martin, A. J. (1999–2022) *Motivation and Engagement Scale*. Lifelong Achievement Group.
Martin, A. J. (2007). Examining a multidimensional model of student motivation and engagement using a construct validation approach. *British Journal of Educational Psychology, 77*, 413–440. https://doi.org/10.1348/000709906X118036

Martin, A. J. (2009). Motivation and engagement across the academic lifespan: A developmental construct validity study of elementary school, high school, and university/college students. *Educational and Psychological Measurement, 69*, 794–824. https://doi.org/10.1177/0013164409332214
Martin, A. J. (2010). *Building classroom success: Eliminating academic fear and failure*. Continuum.
Martin, A. J. (2012). Motivation and engagement: Conceptual, operational and empirical clarity. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement*. Springer. https://doi.org/10.1007/978-1-4614-2018-7_14
Martin, A. J. (2015). Teaching academically at-risk students in middle school: The roles of explicit instruction and guided discovery learning. In S. Groundwater-Smith & N. Mockler (Eds.), *Big fish, little fish: Teaching and learning in the middle years.* Cambridge University Press.
Martin, A. J. (2016). *Using Load Reduction Instruction (LRI) to boost motivation and engagement*. British Psychological Society.
Martin, A. J. (2021). The role of academic engagement in mediating the link between instruction and academic outcomes: New insights from load reduction instruction and the 4M Academic Engagement Framework. In S. Christenson & A. Reschly (Eds.). *Handbook of research on student engagement* (2nd ed). Springer.
Martin, A. J., & Marsh, H. W. (2003). Fear of failure: Friend or foe? *Australian Psychologist, 38*, 31–38.
Martin, A. J., & Dowson, M. (2009). Interpersonal relationships, motivation, engagement, and achievement: Yields for theory, current issues, and practice. *Review of Educational Research, 79*, 327–365. https://doi.org/10.3102/0034654308325583
Martin, A. J., & Evans, P. (2018). Load Reduction Instruction: Exploring a framework that assesses explicit instruction through to independent learning. *Teaching and Teacher Education, 73*, 203–214. https://doi.org/10.1016/j.tate.2018.03.018
Martin, A. J., & Collie, R. J. (2019). Teacher-student relationships and students' engagement in high school: Does the number of negative and positive relationships with teachers matter? *Journal of Educational Psychology, 111*, 861–876.
Martin, A. J., & Evans, P. (2019). Load reduction instruction: Sequencing explicit instruction and guided discovery to enhance students' motivation, engagement, learning, and achievement. In S. Tindall-Ford, S. Agostinho, & J. Sweller (Eds.), *Advances in Cognitive Load Theory: Rethinking teaching.* Routledge.
Martin, A. J., & Evans, P. (2021). Load reduction instruction policy. In K-A. Allen., A. Reupert., & L. Oades (Eds). *Building better schools with evidence-based policy: Adaptable policy for teachers and school leaders*. Routledge.
Martin, A. J., Marsh, H. W., & Debus, R. L. (2003). Self-handicapping and defensive pessimism: A model of self-protection from a longitudinal perspective. *Contemporary Educational Psychology, 28*, 1–36. https://doi.org/10.1016/S0361-476X(02)00008-5
Martin, A. J., Marsh, H. W., McInerney, D. M., & Green, J. (2009). Young people's interpersonal relationships and academic and non-academic outcomes: The relative salience of teachers, parents, same-sex peers, and opposite-sex peers. *Teachers College Record*, *March*, http://www.tcrecord.org
Martin, A. J., Anderson, J., Bobis, J., Way, J., & Vellar, R. (2012). Switching on and switching off in mathematics: An ecological study of future intent and disengagement amongst middle school students. *Journal of Educational Psychology, 104*, 1–18. https://doi.org/10.1037/a0025988
Martin, A. J., Ginns, P., & Papworth, B. (2017). Motivation and engagement: Same or different? Does it matter? *Learning and Individual Differences, 55*, 150–162.
Martin, A. J., Ginns, P., Burns, E. C., Kennett, R., Munro-Smith, V., Collie, R. J., & Pearson, J. (2021). Assessing instructional cognitive load in the context of students' psychological challenge and threat orientations: A multi-level latent profile analysis of students and classrooms. *Frontiers in Psychology, 12*, 656994.
Martin, A. J., Ginns, P., Burns, E. C., Kennett, R., & Pearson, J. (2021b). Load reduction instruction in science and students' science engagement and science achievement. *Journal of Educational Psychology, 113*(6), 1126–1142. https://doi.org/10.1037/edu0000552
Martin, A. J., Kennett, R., Pearson, J., Mansour, M., Papworth, B., & Malmberg, L. E. (2021c). Challenge and threat appraisals in high school science: Investigating the roles of psychological and physiological factors. *Educational Psychology, 41*(5), 618–639. https://doi.org/10.1080/01443410.2021.1887456
Martin, A. J., Ginns, P., Nagy, R. P., Collie, R. J., & Bostwick, K. C. P. (2023). Load reduction instruction in mathematics and English classrooms: A multilevel study of student and teacher reports. *Contemporary Educational Psychology*. https://doi.org/10.1016/j.cedpsych.2023.102147

Marzano, R. J. (2003). *What works in schools*. ASCD.
Marzano, R. J. (2011). Art and science of teaching / The perils and promises of discovery learning. *Educational Leadership, 69*, 86–87.
Mayer, R. E. (2004). Should there be a three-strikes rule against pure discovery learning? The case for guided methods of instruction. *American Psychologist, 59*, 14–19. https://doi.org/10.1037/0003-066X.59.1.14
Mayer, R.E., & Moreno, R. (2010). Techniques that reduce extraneous cognitive load and manage intrinsic cognitive load during multimedia learning. (pp. 131–152). In J.L. Plass., R. Moreno., & R. Brunken (Eds). *Cognitive load theory*. Cambridge University Press. https://doi.org/10.1017/CBO9780511844744.009
McClelland, D. C. (1965). Toward a theory of motive acquisition. *American Psychologist, 20*, 321–333. https://doi.org/10.1037/h0022225
McInerney, D. M., Yeung, A. S., & McInerney, V. (2001). Cross-cultural validation of the Inventory of School Motivation (ISM): Motivation orientations of Navajo and Anglo students. *Journal of Applied Measurement, 2*, 135–153.
Midgley, C., Maehr, M., Hicks, L., Roesser, R., Urdan, T., Anderman, E., Kaplan, A., Arunkumar, R., & Middleton, M. (1997). *Patterns of Adaptive Learning (PALS)*. University of Michigan.
Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, *63*, 81–97. http://www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=0000U6&topic_id=1
Murphy, P. K., & Alexander, P. A. (2000). A motivated exploration of motivation terminology. *Contemporary Educational Psychology, 25*, 3–53. https://doi.org/10.1006/ceps.1999.1019
Nandagopal, K., & Ericsson, K.A. (2012). Enhancing students' performance in traditional education: Implications from the expert performance approach and deliberate practice (pp. 257–293). In K.R. Harris., S. Graham., & T. Urdan (Eds). *APA educational psychology handbook.* American Psychological Association. https://doi.org/10.1037/13273-010
Nolen, S. B. (2020). A situative turn in the conversation on motivation theories. *Contemporary Educational Psychology, 61*, 101866. https://doi.org/10.1016/j.cedpsych.2020.101866
Paas, F., Renkl, A., & Sweller, J. (2003). Cognitive load theory and instructional design: Recent developments. *Educational Psychologist, 38*, 1–4. https://doi.org/10.1207/S15326985EP3801_1
Patrick, B. C., Skinner, E. A., & Connell, J. P. (1993). What motivates children's behavior and emotion? Joint effects of perceived control and autonomy in the academic domain. *Journal of Personality and Social Psychology, 65*, 781–791. https://doi.org/10.1037/0022-3514.65.4.781
Pekrun, R., & Linnenbrink-Garcia, L. (2012). Academic emotions and student engagement. In S. L. Christenson, A.L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 259–282). Springer. https://doi.org/10.1007/978-1-4614-2018-7_12
Piaget, J. (1954/2013) *The construction of reality in the child*. Routledge https://doi.org/10.1037/11168-000
Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology, 95*, 667–686. https://doi.org/10.1037/0022-0663.95.4.667
Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1991). *A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ)*. National Center for Research to Improve Postsecondary Teaching and Learning.
Pollock, E., Chandler, P., & Sweller, J. (2002). Assimilating complex information. *Learning and Instruction, 12*, 61–86. https://doi.org/10.1016/S0959-4752(01)00016-0
Pressley, M., Roehrig, A. D., Raphael, L., Dolezal, S., Bohn, C., Mohan, L., Wharton-McDonald, R., Bogner, K., & Hogan, K. (2003). Teaching processes in elementary and secondary education. In W.M. Reynolds & G.E. Miller (Eds). *Handbook of educational psychology*. John Wiley & Sons. https://doi.org/10.1002/0471264385.wei0708
Purdie, N., & Ellis, L. (2005). *A review of the empirical evidence identifying effective interventions and teaching practices for students with learning difficulties in Years 4, 5, and 6*. Australian Council for Educational Research.
Reeve, J. (2012). A self-determination theory perspective on student engagement. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 149–172). Springer.
Renkl, A. (2014). Toward an instructionally oriented theory of example-based learning. *Cognitive Science, 38*, 1–37. https://doi.org/10.1111/cogs.12086

Renkl, A., & Atkinson, R.K. (2010). Learning from worked-out examples and problem solving. (pp. 91–108). In J.L. Plass., R. Moreno., & R. Brunken (Eds). *Cognitive load theory*. Cambridge University Press. https://doi.org/10.1017/CBO9780511844744.007

Reschly, A.L., & Christenson, S.L. (2012). Jingle, jangle, and conceptual haziness: Evolution and future directions of the engagement construct. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 3–19). Springer https://doi.org/10.1007/978-1-4614-2018-7_1

Rosenshine, B. V. (1995). Advances in research on instruction. *The Journal of Educational Research, 88*, 262–268. https://doi.org/10.1080/00220671.1995.9941309

Rosenshine, B. V. (2009). The empirical support for direct instruction. In S. Tobias & T. M. Duffy (Eds.), *Constructivist instruction: Success or failure?* Routledge.

Rosenshine, B. V., & Stevens, R. (1986). Teaching functions. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed., pp. 376–391). McMillan.

Ryan, R. M., & Deci, E. L. (2010). Promoting self-determined school engagement. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of school motivation.* Routledge.

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology, 61*, 101860. https://doi.org/10.1016/j.cedpsych.2020.101860

Schmidt, H. G., Loyens, S. M., Van Gog, T., & Paas, F. (2007). Problem-based learning is compatible with human cognitive architecture: Commentary on Kirschner, Sweller, and. *Educational Psychologist, 42*(2), 91–97. https://doi.org/10.1080/00461520701263350

Schunk, D. H., & Miller, S. D. (2002). Self-efficacy and adolescents' motivation. In F. Pajares & T. Urdan (Eds.), *Academic motivation of adolescents.* Information Age Publishing.

Schunk, D. H., & Mullen, C. A. (2012). Self-efficacy as an engaged learner. In S. Christenson, A. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement.* Springer.

Schunk, D. H., & DiBenedetto, M. K. (2020). Motivation and social cognitive theory. *Contemporary Educational Psychology, 60*, 101832. https://doi.org/10.1016/j.cedpsych.2019.101832

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research, 78*, 153–189. https://doi.org/10.3102/0034654307313795

Sierens, E., Vansteenkiste, M., Goossens, L., Soenens, B., & Dochy, F. (2009). The synergistic relationship of perceived autonomy support and structure in the prediction of self-regulated learning. *British Journal of Educational Psychology, 79*, 57–68. https://doi.org/10.1348/000709908X304398

Skinner, E. A. (1996). A guide to constructs of control. *Journal of Personality and Social Psychology, 71*(3), 549–570. https://doi.org/10.1037/0022-3514.71.3.549

Skinner, E. A., & Belmont, M. J. (1993). Motivation in the classroom: Reciprocal effects of teacher behavior and student engagement across the school year. *Journal of Educational Psychology, 85*(4), 571–581. https://doi.org/10.1037/0022-0663.85.4.571

Skinner, E. A., & Zimmer-Gembeck, M. J. (2011). Perceived control and the development of coping. In S. Folkman (Ed.), *The Oxford handbook of stress, health, and coping* (pp. 35–59). Oxford University Press.

Skinner, E.A., & Pitzer, J.R. (2012). Developmental dynamics of student engagement, coping, and everyday resilience. In S.L. Christenson, A.L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 21–44). Springer. https://doi.org/10.1007/978-1-4614-2018-7_2

Sweller, J. (2004). Instructional design consequences of an analogy between evolution by natural selection and human cognitive architecture. *Instructional Science, 32*, 9–31. https://doi.org/10.1023/B:TRUC.0000021808.72598.4d

Sweller, J. (2012). Human cognitive architecture: Why some instructional procedures work and others do not (pp. 295–325). In K.R. Harris., S. Graham., & T. Urdan (Eds). *APA educational psychology handbook*. American Psychological Association. https://doi.org/10.1037/13273-011

Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive load theory*. Springer.

Tobias, S., & Duffy, T. M. (Eds.). (2009). *Constructivist instruction: Success or failure?* Routledge.

Urdan, T., & Kaplan, A. (2020). The origins, evolution, and future directions of achievement goal theory. *Contemporary Educational Psychology, 61*, 101862. https://doi.org/10.1016/j.cedpsych.2020.101862

Usher, E. L., & Schunk, D. H. (2018). Social cognitive theoretical perspective of self-regulation. In D. H. Schunk & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (pp. 19–35). Routledge/Taylor & Francis Group.

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Briere, N. M., Senecal, C., & Vallieres, É. F. (1992). The Academic Motivation Scale: A measure of intrinsic, extrinsic and amotivation in education. *Educational and Psychological Measurement, 52*, 1003–1017. https://doi.org/10.1177/0013164492052004025

Van Merriënboer, J. J. (1992). Training complex cognitive skills: A four-component instructional design model for technical training. *Educational Technology Research and Development, 40*, 23–43. https://doi.org/10.1007/BF02297047

Voelkl, K.E. (2012). School identification. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 193–218). Springer. https://doi.org/10.1007/978-1-4614-2018-7_9

Vygotsky, L. S. (1970). *Thought and language*. MIT Press.

Weiner, B. (2010). The development of an attribution-based theory of motivation: A history of ideas. *Educational Psychologist, 45*, 38–36. https://doi.org/10.1080/00461520903433596

Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of motivation. *Contemporary Educational Psychology, 25*, 68–81. https://doi.org/10.1006/ceps.1999.1015

Wigfield, A., & Koenka, A. C. (2020). Where do we go from here in academic motivation theory and research? Some reflections and recommendations for future work. *Contemporary Educational Psychology, 61*, 101872. https://doi.org/10.1016/j.cedpsych.2020.101872

Wiliam, D. (2011). *Embedded formative assessment*. Solution Tree Press.

Winne, P. H., & Nesbit, J. C. (2010). The psychology of academic achievement. *Annual Review of Psychology, 61*, 653–678. https://doi.org/10.1146/annurev.psych.093008.100348

Wong, Z. Y., & Liem, G. A. D. (2021). Student engagement: Current state of the construct, conceptual refinement, and future research directions. *Educational Psychology Review*, 1–32.

Zimmerman, B. J. (2002). Achieving self-regulation. In: F. Pajares & T. Urdan (Eds.). *Academic motivation of adolescents*. Information Age Publishing.

Zimmerman, B. J., & Campillo, M. (2003). Motivating self-regulated problem solvers. In: J. E. Davidson & R. J. Sternberg (Eds.), *The psychology of problem solving* (pp. 233–262). Cambridge University Press.