The Cognitive-Affective-Motivation Model of Learning (CAMML): Standing on the Shoulders of Giants

Kevin S. McGrew

University of Minnesota

Abstract:
The *Cognitive-Affective-Motivation Model of Learning* (CAMML) is a proposed framework for integrating contemporary motivation, affective (Big 5 personality) and cognitive (CHC theory) constructs in the practice of school psychologists (SPs). The central tenet of this article is that SPs should integrate motivation alongside affective and cognitive constructs vis-à-vis an updated trilogy-of-the-mind (cognitive, conative, affective) model of intellectual functioning. CAMML builds on Richard Snow's seminal research on academic aptitudes—which are not synonymous with cognitive abilities. Learning aptitude complexes are academic domain-specific cognitive abilities and personal investment mechanisms (motivation and self-regulation) that in concert produce a student's readiness to learn in a specific domain. CAMML incorporates the "crossing the Rubicon" commitment pathway model of motivated self-regulated learning. It is recommended SPs take a fresh look at motivation theory, constructs, and research, embedded in the CAMML aptitude framework, by going back-to-the-future guided by the wisdom of giants from the field of cognition, intelligence, and educational psychology.

Keywords: Motivation, self-regulated learning, aptitudes, domain-specific, aptitude complexes, Crossing the Rubicon, taxonomies, individual differences, readiness, CHC theory, Big 5, Gf-Gc theory.

Note: This is a pre-copyedited, author-produced PDF of an article accepted for publication in the Canadian Journal of School Psychology.

The official citation for this manuscript is: **McGrew, K. S. (2022). The cognitive-affective-motivation model of learning (CAMML): Standing on the shoulders of giants. *Canadian Journal of School Psychology*, *37*(1), 117-134.** https://doi.org/10.1177/08295735211054270
This paper is not the copy of record and may not exactly replicate the final, authoritative version of the article. The final article will be available, upon publication, via its DOI.

Author Note: Correspondence concerning this article should be addressed to Kevin S. McGrew, Institute for Applied Psychometrics, 1313 Pondview Lane, St. Joseph, MN, 56374. Email: iqmcgrew@gmail.com. The author declares a possible conflict of interest due to his paid consultancy with the Ayrton Senna Institute referenced in this paper, both in 2016 and from 2020 to current. The author declares a financial interest in the WJ IV assessment battery which is also mentioned in this paper. The author thanks Randy Floyd, Ricardo Primi, Paul Vespo, and especially Alan Kaufman, for comments on earlier drafts of this paper.

As described in the introduction to this special *CJSP* issue, although the motivational characteristics of students have long been recognized as important variables for understanding and modifying students school achievement, the topic has largely been ignored in school psychology (SP) training and professional development (Daniels & Dueck, this issue). Reported average effect sizes for motivation (.49) and motivational self-regulated learning (SRL; .69) interventions on academic attainment and motivation-related outcomes (Dignath & Büttner, 2008; Lazowsi & Hulleman, 2016) should command the attention of SPs. Yet, as described by Daniel's and Dueck (this issue), the field of SP has been hindered in efforts to leverage student achievement motivation characteristics due to a lack of frameworks that integrate the diverse range of constructs present in the motivation literature. Finally, early studies investigating the impact of the COVID-19 pandemic on academic learning have suggested that multiple achievement motivation enhancing constructs (e.g., goal orientations, self-beliefs, engagement, interests, perceptions) have been significantly impacted by the disruption of traditional educational learning conditions (Daniels, Goegan & Parker, 2021; Lee, Lim, Allen & Choi, 2021). With an increase in distance and hybrid models of learning, the ability of students to be more independent, motivated and self-regulated learners may now be more important than ever.

The Motivation Jingle-Jangle Jungle (J^3)

Achievement motivation, engagement, goal orientation, locus of control, social-emotional learning, self-efficacy, self-regulated learning, self-determination, the Big 5, grit, and so on. Where does motivation fit in this dizzying array of psychological

constructs in the jingle jangle jungle?[1] School psychologists (SPs) may be overwhelmed by the plethora of terms and theories relevant to contemporary motivation constructs. Yet, as presented in this special *CJSP* issue on motivation, understanding the motivation and SRL of students should occur with regularity in the day-to-day practice of SPs. What are SPs to think?

First, motivation is described here as the cohesive or centripetal force that binds together the core elements of the classic trilogy-of-the-mind (cognition, conation, affect; Hilgard, 1980) in the proposed Cognitive-Affective-Motivation Model of Learning (CAMML). Despite no consensus motivation construct taxonomy (Elliott, Dweck & Yeager, 2017; Hattie, Hodis & Kang, 2020; Murphy & Alexander, 2000), the goals of this paper are two-fold. First, SPs need to understand the core characteristics of achievement competence motivation. Second, SPs need a whole-child framework to situate motivational constructs alongside cognitive and affective constructs. The CAMML framework, built on Richard Snow's model of aptitude complexes and the concept of "crossing the Rubicon" to engaged learning, is presented as an overarching cognitive-affective-conative framework from which SP's can organize educationally relevant student characteristic information to enhance diagnosis and intervention.

Standing on the Shoulders of Giants

The definition of achievement competence motivation, which is the core of the motivation component of CAMML, is derived from Elliott, Dweck and Yaeger's (2017) *Handbook of Competence and Motivation*—the initiation and direction of persistent, sustained, and self-regulated behavior towards a satisfactory level of success on cognitively implicit or explicit achievement goals. Reflecting the seminal influence of

[1] The jingle-jangle jungle "exists when erroneous assumptions are made that two different things are the same because they have the same name (jingle fallacy) or are identical or almost identical things are different because they are labeled differently (jangle fallacy)" (Schneider & McGrew, 2018, p. 143; see Kelly, 1927, for original description of the jingle-jangle fallacy.

Bandura's (1986) social cognitive theory on motivation, individuals are considered agentic contributors to their lives via proactive self-organization, regulation, and reflection. Thus, achievement competence motivation includes the sources or orientations, self-beliefs, and self-regulation of motivation in the pursuit of goals. This contemporary conceptualization of motivation was foreshadowed in the writings of Richard Snow, whose work serves as the foundation of the CAMML framework. Snow's work built on the cumulative effort of scholars who sought to identify conative (aka., non-cognitive)[2] individual difference constructs to sit alongside cognitive abilities to explain intellectual functioning and academic performance.

Motivation, in the context of the study of cognitive abilities, can be traced to the early 1900's. Charles Spearman (1927), the father of general intelligence (*g*), recognized the importance of conative abilities when he stated that "the process of cognition *cannot possibly be treated apart from those of conation and affection* [emphasis added], seeing that all these are but inseparable aspects in the instincts and behavior of a single individual, who himself, as the very name implies, is essential indivisible" (p. 2). David Wechsler similarly stated that "when our scales measure the *nonintellectual* as well as intellectual factors in intelligence, they will more nearly measure what in actual life corresponds to *intelligent behavior* [emphasis added]" (Wechsler, 1943). Finally, Raymond Cattell, when describing how individuals invest their fluid intelligence (g_f) to acquire crystallized intellectual abilities (g_c)[3] (i.e., Cattell's investment hypothesis; Schneider & McGrew, 2018), considered personal investment as occurring through personality and

[2] "Non-cognitive" has been used by a diverse array of individuals both within and outside of scientific psychology (e.g., educators, psychologists, economists, policy makers) to reference a wide array of skills and abilities. The widespread yet inconsistent meaning of the word has led to a general dissatisfaction with the term (Kell, 2018).

[3] The use of the lower-case italic g_f and g_c notation recognizes that Cattell's two *general* abilities are more consistent with the notion of general intelligence (*g*) as articulated by Spearman. This subtle, yet importance difference from Horn and Carroll's broad CHC notation, is maintained in this article. See Schneider and McGrew (2018) for discussion.

affective constructs. Cattell's (1987) wise words, written over 30 years ago, still apply to the state-of-the-art of SPs limited conceptual integration of cognitive, conative and affective constructs in understanding student learning —"The school psychologists of the first half of this century made a big mistake in trying to estimate school performance and scholarship readiness from the I.Q. alone. Typically, only half the variance in grades is thus accounted for, and, as we now realize …much of the rest can be accounted for by predictions from personality and motivation measures" (p. 435).

The *APA Dictionary of Psychology* (VandenBos, 2007) defines conation as "the proactive (as opposed to habitual) part of motivation that connects knowledge, affect, drives, desires, and instincts to behavior. Along with cognition and affect, conation is one of the three traditionally identified components of mind" (p. 210). The cognition, affection, and conation trilogy-of-the-mind "originated in the German faculty psychology of the eighteenth century, but was adopted by the association of psychologists of the nineteenth century of Scotland" (Hilgard, 1980, p.107), and has endured as the overarching model for describing the division of labor characterizing intellectual functioning. Eventually conation experienced a demotion or was merged with affection and the pair considered lessor associates of cognition (Snow & Farr, 1987). The central thesis of this article is that this ageless trilogy should be resurrected in the form of a revised academic aptitude framework.

Motivation's Place in an Updated Trilogy-of-the-Mind

CAMML has its origins in McGrew and Evans (2004) National Center of Educational Outcomes (NCEO; https://nceo.info/) report that advocated for high expectations for students with disabilities during the US NCLB-driven educational reform efforts (circa 2002 to 2015). McGrew and Evans (2004) reminded professionals and policy-makers that IQ tests are fallible predictors of expected achievement as achievement test scores are normally distributed around every IQ score (after adjusting for regression to the mean). Expected achievement for any IQ score can display a band

of expected achievement close to 22 standard score points (± 11) for approximately 2/3 of the population. The point is clear—IQ test scores should not be used as an excuse to formulate lower academic expectations for students with disabilities. We need to look beyond IQ.

After a comprehensive review of the literature, McGrew, Johnson, Cosio and Evans (2004) concluded that Richard Snow's school-related aptitude research program provided a provisional taxonomy for integrating individual difference constructs as per the trilogy-of-the-mind framework (Corno et al., 2002; Snow & Farr, 1987). Unfortunately, most of Snow's work has inexplicably flown under the radar screen of most of SP. It is hoped this article corrects this oversight and places motivational constructs in a "big picture" perspective.

The CAMML motivation (conative) constructs are drawn from a review of over a dozen motivation-related theories.[4] As depicted in the left half of the model in Figure 1, the motivational constructs are organized as per Snow's two primary conative constructs of motivation and volition.

Insert Figure 1 about here

The Motivation Component of the CAMML Framework

Motivational (Conative) Constructs

Hattie, Hodis and Kang (2020) and Murphy and Alexander's (2000) reviews delineated the major paths through the motivation jingle-jangle-jungle. The motivation domain represents the sources for initiating specific actions and includes the subareas of achievement orientations and self-beliefs (see Figure 1). The most construct valid

[4] The motivation constructs included in the CAMML framework are drawn from earlier efforts to develop the Model of Achievement Competence Motivation (MACM). A detailed explanation of the evolution and development of the MACM model is available elsewhere (McGrew et al., 2004). A series of recent MACM PowerPoint® modules are available at https://tinyurl.com/y3sjmj9w.

achievement orientation subdomains are academic goal orientation, academic intrinsic motivation, and academic interests. Self-belief constructs, of which there are many, are restricted to academic self-concept and self-efficacy. Self-beliefs are motivational as they prompt a student to either invest in and approach certain academic tasks, or conversely, prompt a student to avoid certain academic tasks. Given the absence of a consensus motivation construct taxonomy, these motivation and volition constructs are represented in Figure 1 as practice-friendly sets of questions. These questions help organize informal and formal assessment information related to student motivation. Definitions of these core motivation terms are available at http://www.iapsych.com/motivationdefs.pdf.[5]

Achievement orientations and self-beliefs produce the first three states of motivational readiness to act (wish→want→intention→action), or what is frequently called the planning, pre-decisional or prepatory phase of motivation (Corno, 1993; Heckhausen & Golliwitzer, 1987; Huh & Reigeluth, 2017). The motivation constructs can be considered the *drivers* (in the sense of energizing and propelling something forward) of behavior.

In Figure 1 the achievement orientation and self-belief constructs are organized around core achievement domains (hexagon white spaces). This schematic illustrates the trend in contemporary achievement motivation research towards academic or task-domain specific constructs (Murphy & Alexander, 2000).[6] The constructs surrounding the central achievement domain represents the finding, either based on causal or structural research (e.g., see Payne, Satoris & Youngcourt, 2007), that during motivated

[5] It should be noted that the motivation domain focuses on core individual difference constructs and does not include environmental factors or other potentially important motivation constructs such as cost/benefit evaluative judgements or task attributes as included in the popular expectancy-value model of academic motivation (Eccles & Wigfield, 2002).

[6] The hexagons with the "…?" notation represent the never-ending evolution of the motivation jingle-jangle-jungle.

learning these constructs are interconnected much like constellations, configurations, complexes, or, in the case of self-beliefs, self-schemas (Murphy & Alexander, 2000; Pomerance, Converse, & Moon, 2020). These construct complexes do not represent latent factors. The complexes indicate that the neighboring constructs are often correlated or represent different facets or dimensions of a singular construct (e.g., self-concept as comprised of knowledge and evaluative components; Pomerance et al., 2020). In simple terms, measures of these different motivation constructs tend to "hang together" in empirical studies or often overlap in definitional space in the motivation literature.

Volition, a relatively old psychological term that has waxed and waned in use over time, represents the post-decisional, action, or performance phase of motivated learning. In contemporary research volition has been replaced by terms like action controls and self-regulated learning (SRL). This domain, which is typically not considered domain-specific, can be conceptualized as the *directors* of behavior, in the sense of controlling, managing, and regulating. SRL is related to, but should not be confused with, self-regulation, meta-cognition, or executive functioning. SRL is subsumed by the more general concept of self-regulation which can focus on cool (cognitive) or hot (emotion) regulatory mechanisms. "SRL is a subtype of self-regulation directed toward academic achievements and non-academic skill development (e.g., musical or athletic skill). Thus, learning is a core focus of SRL" (Callan, Yang, Zhang & Sciuchetti, 2020).

Snow (1996) suggested that SRL was the "overarching conative concept" (p. 262) and thus, subsumes all motivation and SRL (volition) constructs. Although six primary SRL models are present in the literature, the three- and four-phase Zimmerman (2001) and Pintrich (Pintrich & Zusho, 2002) models are the most dominant and research-based (Callan et al., 2020; Panadero, 2017). The similarities between these two models resulted in the combined three-phase SRL model presented in Figure 1 (also see Puustinen & Pulkkinen, 2001). It should be noted that the

neat, tidy, and idealized components and cyclical phases in SRL models fail to accurately capture the fluid nature of these core motivational and self-efficacy beliefs during learning (e.g., see the Continuous-Change Framework for self-regulated learning; Huh & Reigeluth, 2017).

The Affective-Conative (Motivation) Link

The model in Figure 1 presents the hypothesized link between the affective and conative constructs of motivation and self-regulated learning (SRL or volition). The distal-to-proximal learning influence link between affective (personality) and conative constructs (motivation and SRL) is mediated primarily by the Big 5 personality traits of Openness to Experience (O) and Conscientiousness (C; Mammadov, 2021) and 8 of 17 social-emotional facets.[7] The affective→conative bridge portrayed in Figure 1, which indicates that personality trait effects are transmitted or mediated through the more proximal conative characteristics, is grounded in multiple sources of research (Burrus & Brenneman, 2016; Corno et al., 2002; Lipnevich, et al., 2016; Mammadov, 2021; Poropat, 2009; Vedel, 2014). This link has been solidified by recent research integrating social-emotional (SE) constructs within the Big 5 theory, the consensus taxonomy of personality traits. The Big 5 model (John, Naumann, & Soto, 2008) includes the traits of Extraversion (E), Agreeableness (A), Conscientiousness (C), Negative emotionality (N), and Open-mindedness (O).

Led by researchers at the Ayrton Senna Institute in Brazil[8], an international team of scholars integrated the most prominent SE models into a single Big-5 organized framework (Abrahams, Pancorbo, Primi, Santos, Kyllonen, John, & De Fruyt; John & De

[7] Conscientiousness is the most robust Big 5 predictor of academic performance. The Openness to Experience trait relationship with academic performance may be moderated by age and education level, with decreasing strength as a function of age and increased educational level. Agreeableness has also demonstrated significant, albeit weak, relations with academic performance, moderated by eduction level (i.e., stronger at younger grades; Mammadov, 2021).

[8] https://institutoayrtonsenna.org.br/en/our-initiatives.html

Fruyt, 2015).[9] This was followed by a series of analyses of item pools of commonly used SE measures (e.g., personality, self-beliefs, grit, locus of control, self-efficacy, self-esteem, etc.). The result was the validation of the SENNA SEMS (social-emotional) model and inventory (Abrahams et al., 2019; Pancorbo, Primi, John, Santos, Abrahams, De Fruyt, 2020; Primi, Santos, John, De Fuyrt, 2016). The 17 SENNA SEMS social-emotional facets (see Figure 1) provide an intermediate mediating link between affective (Big 5 personality) and conative (motivation and SRL) constructs. The SENNA SEM facets, and particularly the Open-mindedness (O) facets of curiosity to learn, creativity, imagination, artistic interest and the Conscientiousness/Self-management (C) facets of determination, organization, focus, persistence, and responsibility, connect the more general, stable and distal-to-learning personality traits with the more narrow, malleable, and proximal-to-learning motivational constructs.[10] The affective personality constructs are similar to the concept of *dispositions* (i.e., the tendency or typical way of acting or feeling).

Crossing the Rubicon to Learning Model

The complete CAMML framework is presented in Figure 2 and is an adaptation and extension of Snow's dynamic conation model of school-related learning (Corno, 1993). It requires, in addition to the affective constructs, cognitive constructs. Cognition is represented by the contemporary CHC theory of cognitive abilities (McGrew, 2009; Schneider & McGrew, 2018).

Insert Figure 2 about here

---

[9] The Harvard Explore SEL web page (https://tinyurl.com/y6ysb3sn) allows individuals to navigate and compare over three dozen major SE frameworks.

[10] The temperament traits and characteristic moods included in the Figure 1 are not primary features of the CAMML model.

The CAMML framework can assist SPs see the "forest-from-the-trees" and thus, increase the chance of successfully integrating motivation concepts in their daily practice. CAMML incorporates the seminal work of Heckhausen who linked motivation and SRL in the commitment pathway model of action (wish→want→intention→action), or what Heckhausen described as the Rubicon model of action phases (Heckhausen, 2020; Huh & Reigeluth, 2017).[11]

The achievement domain-specific self-belief and achievement orientation complexes are ordered from left to right, consistent with literature suggesting that self-beliefs are antecedent to motivational orientations during learning (Payne et al., 2020). Also, both domain-specific complexes are organized around the same core achievement domain, representing the concept that self-belief and achievement orientation complexes work synergistically to drive behavior to attain the target academic domain goals.

As illustrated in Figure 2, motivation and SRL constructs, distally influenced by affective (dispositional) constructs, drive the process of investing cognitive abilities (Cattell's g_f and the CHC broad constructs of Gf, Gv, Ga, Gwm, Gl, Gr, and Gs) during learning. The end products are crystallized acquired knowledge systems (Cattell's g_c; CHC broad Gc, Grw, and Gq). During the preparatory phase (wish→want→intention), learners contemplate and plan vis-à-vis a complex (likely person-specific) interaction of domain-specific achievement orientation and self-belief complexes. Once the decision is made to act, the learner commits to "crossing the Rubicon" to engaged learning toward the desired goals (wish→want→intention→action). Performance and appraisal SRL mechanisms are required to maintain, regulate, or correct (direct) the goal-directed learning processes. In simple terms, motivation constructs kick start (drive) the

[11] Today "crossing the Rubicon" is an idiom describing a decision point of no return. It is based on Julius Caesar's historical crossing of the Rubicon River that precipitated the Roman Civil War. https://en.m.wikipedia.org/wiki/Crossing_the_Rubicon.

commitment pathway to learning which then requires SRL mechanisms to steer or direct the course to attain the desired goals. Together Figures 1 and 2 represent the overarching CAMML framework SPs can use to better understand: (a) how motivation and SRL constructs can be situated in the individual differences and learning literature, (b) how CHC cognitive abilities are invested in learning (via motivation and SRL), and (c) how distal personality dispositions indirectly impact learning readiness.[12]

Snow's Aptitude Complexes

The typical meaning of aptitude in English-language mainstream psychology has strayed from the original European usage that focused on the person-in-situation and defined aptitude as not being "limited to intelligence or some fixed list of differential abilities but includes personality and motivational differences along with styles, attitudes, and beliefs as well" (Snow, 1991, p. 205). Aptitude, as per Snow et al., (1996), includes "aspects of personality—achievement motivation, freedom from anxiety, appropriately positive self-concept, control of impulses, and others—are aptitudes as well, contributing importantly to coping with some challenges (p. 4)." Snow's model of aptitude is central to the CAMML framework as it includes most all prominent personal characteristics that affect one's learning (Kyllonen & Lajoie, 2003).

Academic aptitude is the multivariate repertoire of cognitive-conative-affective (CAMML) complexes or constellations (see Ackerman, 2018 and Kyllonen, 2003) that represents a student's readiness to learn and perform well in different settings (Corno et al., 2003). The concept of readiness to learn implies potentiality to profit from instruction, or the ability to acquire competence (Bingham, 1942, p. 18). This contrasts

[12] It is native to suggest that motivated SRL follows the neat linear process portrayed in Figure 2. The messy world of classrooms includes competing goals, some of which require a focus on the self-regulation of affective well-being goals of the student.

with the concept of ability, which has a more deterministic connotation and is typically understood as a power to carry out a specific type of task (e.g., reasoning) at a certain threshold level of competence (Corno et al., 2002).

Pivotal to appreciating Snow's thinking is recognizing that aptitude is more than cognitive abilities. Conative constructs, such as motivation and SRL, play a prominent role in explaining how students invest (or fail to invest) their cognitive abilities to achieve certain outcomes. Consistent with comprehensive literature reviews (Nagaoka, Farrington, Ehrlich & Heath, 2015), recent large scale research studies (Casillas, Robbins, Allen, Kuo, Hanson & Schmeiser, 2012; Kuo, Casillas, Allen & Robbins, 2020) that included measures of the cognitive-conative-affective (CAMML) triad reported that conative and affective measures provide important prediction of school achievement above and beyond cognitive measures.

Snow's concept of academic aptitude considers the totality of an individual's cognitive (Cattell g_f/g_c and CHC broad abilities) and personal investment characteristics (i.e., affective variables such as the key Big 5/SENNA SEM trait facets; motivation and SRL conative variables) as working synergistically in the form of CAMML complexes to explain achievement outcomes. This is what is portrayed in the complete CAMML model presented in Figure 2. The CAMML aptitude complex model is conceptually like Ackerman's (2018) Intelligence-as-Process, Personality, Intelligence-as-Knowledge, Interests (PPIK) model of trait complexes.[13]

Relevance to the Practice of School Psychology

[13] The CAMML aptitude complexes are like Ackerman's conceptualization of complexes as variables that in some way intercorrelate as amalgams. This differs from Snow's original notions where complexes were conceptualized as working as interactions (in the classic experimental psychology sense of the term; Kyllonen & Lajoie, 2003).

Integrating CAMML aptitude-trait complexes, which emphasize that motivation and SRL constructs are the focal personal investment learning mechanisms, in contemporary SP practice is an aspirational goal. The constraints of regulatory frameworks and the understandable skepticism of disability-specific advocacy groups will make such a paradigm-shift difficult. However, embracing the model of CAMML aptitude complexes may be what SP and education need to better address the complex nuances of individual differences in student learning. Snow's concept of aptitude, if embraced in reborn form as the CAMML framework, could reduce the unbalanced emphasis on intelligence testing in SPs assessment practices. However, the greatest impediment to change may be the inertia of tradition in SP.

SP Should Recognize Snow's Seminal Work on Aptitudes

Consistent with the introductory article in this issue (Daniels & Dueck, this issue) that reported finding few motivation articles in past *CJSP* issues, special issues devoted to motivation in the *Journal of School Psychology* (Gilman & Anderman, 2006) and *School Psychology Review* (DiPerna & Elliott, 2002) included no stand-alone reference to the seminal work of Snow. This neglect is also present in recent SP articles that addressed motivational constructs (e.g., Callan, Yang, Zhang & Sciuchette, 2020; Clearly, 2009; Clearly, Gubi & Prescott, 2010). In partial defense of SP, the impact of Snow's nearly 40 years of educational psychology research was derailed by his premature death in 1997, a time when he had preliminary plans for two books to present his ideas, concepts, and models.

Most SP assessment resources either fail to recognize Snow's seminal work on learning aptitudes or perpetuate the restricted notion of aptitude as either general intelligence or a mixture of cognitive abilities (e.g., Canivez, 2013; Kranzler & Floyd,

2020). In a recent *CJSP* article addressing the value of popular intelligence testing practices in SP (Farmer, McGill, Dombrowski & Canivez, 2020), seven assessment sources were listed. Even though one included the term "aptitude" in its title (Canivez, 2013), none included any earnest discussion of Snow's concept of aptitude, aptitude complexes, or his proposed taxonomy of aptitude characteristics. All sources either: (a) included no aptitude term in their topic index, (b) equated aptitude with abilities measured by intelligence tests, (c) included no reference to Snow's writings, or (d) only included citations to Snow's collaboration with Lee Cronbach in their seminal publication on aptitude-treatment-interactions (ATI's; Cronbach & Snow, 1977). Reference to the Cronbach and Snow's (1977) classic ATI publication was typically to underscore the point that cognitive-based educational ATI's have not be sufficiently proven, typically in the context of arguments against the value of intelligence test interpretation beyond the total *g* IQ score (Farmer et al., 2020; Kranzler & Floyd, 2020).

In this authors opinion, mainstream SP has concluded that Snow's primary contribution to SP is his 1977 book (with Cronbach) that has been interpreted as the seminal verdict that IQ-based subtest or composite score-based ATI's do not exist. This conclusion is accurate and is undisputed (Kranzler & Floyd, 2020). Snow's early ATI research was indeed focused on cognitive abilities and failed to demonstrate robust ATI's beyond psychometric *g*. As a result, much of academic SP has been "stuck on *g*", a theoretical construct recently characterized as the being a "black hole" (Bruton, 2021) or the Loch Ness Monster of psychology (McGrew, in press). Yet, as early as 1984, Snow was moving the Stanford Aptitude Research Project (started in 1974) to a broader whole-child definition of aptitude. Snow (1984) stated that "our descriptive theory development had to be limited to cognitive aptitude, at least initially, even though it was clear that conative and affective aspects of aptitude would eventually need to be incorporated" (p. 350). By 1987, Snow's revised and expanded notion of aptitude had

crystallized. Snow and Farr (1987) stated that "the general improvement of instruction ultimately requires a whole person view that integrates cognitive, conative, and affective aspects of learning, and individual differences therein. The convenient fiction that has long separated theories of cognitive and affective behavior, and caused the conative aspects of behavior to be more or less ignored, must eventually be discarded in the analysis of aptitude, learning, and instruction. These are three facets of individual performance, not isolated provinces, and they undoubtedly interact in complex ways during learning and problem solving" (p. 1). Snow (1987) had moved on to the "study of *aptitude complexes*—wherein the joint functioning of cognitive, conative, and affective processes in individual differences in learning from instruction is examined" (p. 12). This message was recently echoed by Protzoko and Colom (2021) who remined psychologists that one cannot understand intelligence in isolation from other psychological traits as "all the relevant variables preceding ostensible behavior are cooked in the same pot (the brain) (p.5)." The CAMML framework is proposed to help SPs understand and integrate Snow's concept of academic aptitude complexes in their work with students.

What is troublesome for our profession is that many SP leaders, trainers, and researchers have ignored the corpus of Snow's aptitude research save for his seminal collaboration with Cronbach in 1977. SPs are encouraged to read the posthumously published *Remaking the Concept of Aptitude: Extending the Legacy of Richard E. Snow* (Corno et al., 2002) to appreciate Snow's significant contributions to education and to understand how the CAMML Rubicon model of motivated learning is built on the shoulders of a genuine giant in educational psychology.[14]

[14] As a warning, this book is recommended for the concepts and ideas. It is dated and was written posthumously by a committee of Snow's ex-students and, at times, does not flow easily…after all, it was written by a committee.

Finding a Path Through the Jingle-Jangle Jungle (J^3)

The term aptitude is buried deep in the Amazon **J^3.** The term carries the historical baggage of being the principal term describing decades of testing designed to match individuals to specific occupations. SP needs fresh terms that accurately reflects Snow's ideas of learning, academic readiness, aptitudes, and aptitude complexes, which are represented as the individual difference constructs in CAMML. But we must be careful to not add more confusion to the psychology **J^3.** At the most technical level, this author proposes using learning aptitude or learning readiness complexes (LACs, LRCs, or LARCs) to describe each student's unique amalgam of CAMML individual difference characteristics.

Until we attain clarity regarding the most important, yet hazy constructs in the motivation **J^3**, SPs are urged to use the pragmatic set of questions featured in the motivation component of the CAMML model (see Figure 1). The pragmatic motivation and SRL questions can structure applied discourse until a robust consensus construct taxonomy is established. Using the language of personal investment, committing to the pathway of engaged learning, or crossing the Rubicon might be better suited to conveying the essence of the causal mechanisms of motivated SRL. Perhaps the colloquial terms of dispositions, drivers, and directors (the 3-D model) should be used to discuss motivation SRL individual difference constructs.

This author is not suggesting a complicated multivariate psychometrically derived CAMML-based aptitude complex metric to diagnose and classify students for special services. Enough journal space and social media discourse bandwidth has been devoted to debating different assessment, diagnostic, and classification systems, especially for SLD. Rather, the proposal is to embrace the concept of understanding the

whole child by broadening the scope of traditional SP assessment practices to regularly assess key CAMML learning characteristics that move beyond IQ.

Cognitive assessment would still have a place in assessments, but it would require a movement away from the knee-jerk or routine comprehensive or core IQ test battery administration. Cognitive assessments would be more limited, selective, and referral-focused assessments (McGrew & Wendling, 2010) of the key achievement domain-specific cognitive abilities for the specific referral concern (e.g., fluid reasoning-Gf, visual spatial-Gv, and working memory-Gwm in the case of a middle school student with math difficulties). Kranzler and Floyd (2020) have similarly endorsed selective cognitive ability testing within an evidence-based model of intelligence testing practices. It should be noted that SPs have long possessed cognitive batteries that feature selective testing options (e.g., all editions of the WJ batteries) and recommendations that users of the popular cross-battery method design "highly individualized assessment batteries" (Flanagan, Costa, Palma, Leahy, Alfonso & Ortiz, 2018, p. 770). Per chance embracing the CAMML aptitude complex assessment approach can provide SPs the motivation to "cross the Rubicon" to embrace more selective intelligence testing.[15]

CAMML aptitude complex-oriented assessments would focus on describing the unique and more manipulable instructional levers for students, be it accommodating for a specific cognitive weaknesses (e.g., weakness in Gf or fluid reasoning as mentioned in the earlier math-related assessment example), trying to modify locus of control or competence (growth or fixed) mindsets, working with (or trying to modify) a

[15] Although the focus of this article is on the more traditional model of SPs vending services via a focus on individual children the CAMML framework described here is also relevant to calls for more systemic, prevention, and indirect SP service delivery focused on changing school or classroom practices for all children (Perfect & D'Amato, 2012).

student's particular goal orientation, increasing self-efficacy in an specific academic domain, or some mixture of the above. In response-to-intervention (RTI) models, these assessments could be used when and if a student demonstrates resistance to interventions. The proposed CAMML aptitude complex approach would focus on describing and understanding for interventions—not diagnosis or classification.

Closing Thoughts

Although interest in motivation and SRL has increased among SP researchers, practicing SPs infrequently assess these student characteristics due to a lack of training and expertise in motivation and SRL theories, research, assessment tools, and interventions (Cleary & Zimmerman, 2012). There is a need for increased pre- and in-service SP training. Also, the proposed CAMML framework, although built on nearly a century of research and theorization, is clearly speculative and needs to be researched.

Systemic paradigm changes are often facilitated by abrupt threats to societies (Gilman & Codding, 2024). The current world-wide COVID-19 crises, which has had a major impact on the education of children now, and likely into the future, may provide the necessary nudge for change. Students learning via distance learning models, or those engaged in constantly shifting hybrid models of learning, will need stronger self-motivation and independent SRL abilities in the shift away from the traditional "industrial-age" paradigm of education (i.e., regularly scheduled, structured, in-class teacher-directed learning) to an "information-age" paradigm of education, a paradigm that requires a fuller expression of motivated SRL (Huh & Reigeluth, 2017). Positive motivation and SRL competencies may become just as, or more important and valued, than traditional academic outcomes. New mixtures of CAMML aptitude complexes may be required to adapt and learn to the externally induced changes in the delivery of instruction. The time may never be better for SP to take a fresh look at contemporary

motivation theory, constructs, and research, embedded in the Snow-inspired CAMML aptitude complex framework, by paradoxically going back-to-the-future guided by the wisdom of multiple giants in the field of educational psychology.

References

Abrahams, L., Pancorbo, G., Primi, R., Santos, D., Kyllonen, P., John, O. P., & De Fruyt, F. (2019). Social-emotional skill assessment in children and adolescents: Advances and challenges in personality, clinical, and educational contexts. *Psychological Assessment, 31*(4), 460–473.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, N.J.: Prentice-Hall.

Benson, N. F., Floyd, R. G., Kranzler, J. H., Eckert, T. L., Fefer, S. A., & Morgan, G. B. (2019). Test use and assessment practices of school psychologists in the United States: Findings from the 2017 National Survey. *Journal of School Psychology*, *72*, 29-48.

Bingham, W. (1942). *Aptitudes and aptitude testing*. New York: Harper and Brothers Publishers.

Bruton, O. J. (2021). Is there a "*g*-neuron"? Establishing a systematic link between general intelligence (*g*) and the von Economo neuron. *Intelligence*, *86*, 101540.

Burrus, J., & Brenneman, M. (2016). Psychosocial skills: Essential components of development and achievement in K-12. In A. L. Lipnevich, F. Preckel and R. D. Roberts (Eds.), *Psychosocial skills and school systems in the 21st century* (pp. 3-27). Switzerland: Springer International Publishing.

Callan, G., Yang, N. J., Zhang, Y., & Sciuchetti, M. B. (2020). Narrowing the research to practice gap: A primer to self-regulated learning application in school psychology. *Contemporary School Psychology*, 1-14. https://link.springer.com/article/10.1007/s40688-020-00323-8.

Canivez, G. L. (2013). Psychometric versus actuarial interpretation of intelligence and related aptitude batteries. In D. H. Saklofske, C. R. Reynolds, & V. L. Schwean (Eds.), *The Oxford handbook of child psychological assessments* (pp. 84-112). New York: Oxford University Press.

Casillas, A., Robbins, S., Allen, J., Kuo, Y. L., Hanson, M. A., & Schmeiser, C. (2012). Predicting early academic failure in high school from prior academic achievement, psychosocial characteristics, and behavior. *Journal of Educational Psychology*, *104*(2), 407.

Cattell, R. B. (1987). *Intelligence: Its structure, growth and action*. New York: Elsevier Science Publishers.

Cleary, T. J. (2009). School-based motivation and self-regulation assessments: An examination of school psychologist beliefs and practices. *Journal of Applied School Psychology*, *25*(1), 71-94.

Cleary, T. J., Gubi, A., & Prescott, M. V. (2010). Motivation and self-regulation assessments: Professional practices and needs of school psychologists. *Psychology in the Schools*, *47*(10), 985-1002.

Cleary, T. J., & Zimmerman, B. J. (2012). A cyclical self-regulatory account of student engagement: Theoretical foundations and applications. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 237-257). Springer, Boston, MA.

Corno, L. (1993). The best-laid plans: Modern conceptions of volition and educational research. *Educational Researcher, 22*(2), 14-22.

Corno, L. (2001). Volitional aspects of self-regulated learning. In B. J. Zimmerman, & D. H. Schunk (Eds.), *Self-regulated learning and academic achievement: Theoretical perspectives* (2 ed., pp. 191-225). Mahwah, NJ: Lawrence Erlbaum.

Corno, L., Cronbach, L., Kupermintz, H., Lohman, D., Mandinach, E., Porteus, A., & Talbert, J. (2002). *Remaking the concept of aptitude: Extending the legacy of Richard E. Snow.* Mahwah, NJ: Lawrence Erlbaum Associates.

Cronbach, L. J., & Snow, R. E. (1977). *Aptitudes and instructional methods: A handbook for research on interactions*. New York: Irvington.

Daniels, L. M. & Dueck, B. S. (in press). Integrative and theoretical reviews of achievement motivation for school psychologists. *Canadian Journal of School Psychology*.

Daniels, L. M., Goegan, L. D., & Parker, P. C. (2021). The impact of COVID-19 triggered changes to instruction and assessment on university students' self-reported motivation, engagement and perceptions. *Social Psychology of Education*, *24*(1), 299-318.

Dignath, C., Büttner, G. (2008). Components of fostering self-regulated learning among students. A meta-analysis on intervention studies at primary and secondary school level. *Metacognition Learning, 3*, 231-264.

DiPerna, J. C., & Elliott, S. N. (2002). Promoting academic enablers to improve student achievement: An introduction to the mini-series. *School Psychology Review*, *31*(3), 293-297.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53*, 109-132.

Elliot, A. J., Dweck, C. S., & Yeager, D. S. (Eds.). (2017). *Handbook of competence and motivation: Theory and application (2nd Ed)*. New York: Guilford Publications.

Farmer, R. L., McGill, R. J., Dombrowski, S. C., & Canivez, G. L. (2020). Why questionable assessment practices remain popular in school psychology: Instructional materials as pedagogic vehicles. *Canadian Journal of School Psychology, 36(2),* 98-114.

Flanagan, D. P., Costa, M., Palma, K., Leahy, M.A., Alfonso, V.C., & Ortiz, S.O. (2018). Cross-battery assessment, the cross-battery assessment software system, and the assessment-intervention connection. In D. P. Flanagan & E. M. McDonough (Eds.), *Contemporary Intellectual Assessment: Theories, Tests, and Issues* (4th Edition). New York: Guilford.

Gilman, R., & Anderman, E. M. (2006). Motivation and its relevance to school psychology: An introduction to the special issue. *Journal of School Psychology*, *5*(44), 325-329.

Gilman, R., & Codding, R. S. (2021). Academic journals can and should contribute to the future of school psychology. *School Psychology, 35*(6), 457-461.

Gollwitzer, P. M. (1996). The volitional benefits of planning. In P.M. Gollwitzer, & J.A. Bargh (Eds.), *The psychology of action: Linking cognition and motivation to behavior* (pp. 287-312). New York: Guilford.

Hattie, J., Hodis, F. A., & Kang, S. H. K. (2020). Theories of motivation: Integration and a ways forward. *Contemporary Educational Psychology, 61*, 101865.

Heckhausen, H., and Gollwitzer. P. M. (1987). Thought contents and cognitive functioning in motivational versus volitional states of mind. *Motivation and Emotion, 11*(2), 101-120.

Heckhausen, J. (2020). Integrating and instigating research on person and situation, motivation, and volitions, and their development. *Motivation Science, 6*(3), 185-188.

Hilgard, E. R. (1980). The trilogy of mind: Cognition, affection, and conation. *Journal of the History of the Behavioral Sciences*, *16*(2), 107-117.

Huh, Y., & Reigeluth, C. M. (2017). Self-regulated learning: The continuous-change conceptual framework and a vision of new paradigm, technology system, and pedagogical support. *Journal of Educational Technology Systems*, *46*(2), 191-214.

John, O. P., Naumann, L. P., & Soto, C. J. (2008). Paradigm shift to the integrative big five trait taxonomy. *Handbook of personality: Theory and research*, *3*(2), 114-158.

John, O. P. & De Fruyt, F. (2015). *Education and social progress: Framework for the longitudinal study of social and emotional skills in cities.* Paris: OECD Publishing.

Kell, H. J. (2018). Noncognitive proponents' conflation of "cognitive skills" and "cognition" and its implications. *Personality and individual differences*, *134*, 25-32.

Kranzler, J. H., & Floyd, R. G. (2020). *Assessing intelligence in children and adolescents: A practical guide for evidence-based assessment*. London: Rowman & Littlefield Publishers.

Kuo, Y. L., Casillas, A., Allen, J., & Robbins, S. (2020). The moderating effects of psychosocial factors on achievement gains: A longitudinal study. *Journal of Educational Psychology*. https://psycnet.apa.org/doi/10.1037/edu0000471.

Kyllonen, P. C., & Lajoie, S. P. (2003). Reassessing aptitude: Introduction to a special issue in honor of Richard E. Snow. *Educational Psychologist*, *38*(2), 79-83.

Lazowski, R. A. & Hulleman. C. S. (2016). Motivation interventions in education: A meta-analytic review. *Review of Educational Research, 86*(2), 602-640.

Lee, J., Lim, H., Allen, J., & Choi, G. (2021). Effects of learning attitudes and COVID-19 risk perception on poor academic performance among middle school students. *Sustainability*, *13*(10), 5541; https://doi.org/10.3390/su13105541

Lipnevich, A. A., Preckel, F. & Roberts, R. D. (2016) (Eds.). *Psychosocial skills and school systems in the 21st century: Theory, research, and practice*. Switzerland, Springer, 2016.

Mammadov, S. (2021). The Big Five Personality Traits and Academic Performance: A Meta-Analysis. *Journal of Personality*. https://doi.org/10.1111/jopy.12663

McGrew, K. (2009). Editorial. CHC theory and the human cognitive abilities project. Standing on the shoulders of the giants of psychometric intelligence research, *Intelligence, 37*, 1-10.

McGrew, K. S., & Evans, J. J. (2004). *Expectations for students with cognitive disabilities. Is the cup half empty or half full? Can the cup flow over? Synthesis Report 54*. Minneapolis, MN: University of Minnesota, National Center on Educational Outcomes. https://eric.ed.gov/?id=ED518644.

McGrew, K. M., Johnson, D., Cosio, A., & Evans, J. J. (2004). *Increasing the chance of no child being left behind. Beyond cognitive and achievement abilities*. Minneapolis, MN: Institute on Community Integration, University of Minnesota. http://www.iapsych.com/articles/mcgrew2004.pdf.

McGrew, K. S. (in press). Is the intellectual functioning component of AAIDD's 12th manual satisficing. *Intellectual and Developmental Disabilities.*

Murphy, P. K., & Alexander, P. A. (2000). A motivated exploration of motivation terminology. *Contemporary Educational Psychology, 25,* 3-53

Nagaoka, J., Farrington, C. A., Ehrlich, S. B., & Heath, R. D. (2015). *Foundations for Young Adult Success: A Developmental Framework. Concept Paper for Research and Practice*. University of Chicago Consortium on Chicago School Research. 1313 East 60th Street, Chicago, IL 60637.

Panadero, E. (2017). A review of self-regulated learning: Six models and four directions for research. *Frontiers in psychology*, *8*:422 doi: 10.3389/fpsyg.2017.0042

Pancorbo, G., Primi, R., John, O. P., Santos, D., Abrahams, L., De Fruyt, F. (2020). Development and psychometric properties of rubrics for assessing social-emotional skills in youth. *Studies in Educational Evaluation, 67*. https://doi.org/10.3389/fpsyg.2017.00422.

Payne, S. C., Youngcourt, S. S., & Beaubien, J. M. (2007). A meta-analytic examination of the goal orientation nomological net. *Journal of Applied Psychology, 92*(1), 128-150.

Protzko, J., & Colom, R. (2021). A new beginning of intelligence research. Designing the playground. *Intelligence*, *87*, 101559.

Perfect, M. M. & D'Amato (2020). Introduction to special issue on the history and future of proactive school psychology: Transcending the past, excelling in the present, and transforming the future. *School Psychology, 35*(6), 363-366.

Pintrich, P. R., & Zusho, A. (2002). The development of academic self-regulation: The role of cognitive and motivational factors. In A. Wigfield, & J.S. Eccles (Eds.), *Development of achievement motivation* (pp. 250-284). San Diego: Academic Press.

Pomerance, M. H., Converse, P. D., & Moon, N. A. (2020). Self-concept content and structure: Motivation and performance implications, *Personnel Review*. https://www.emerald.com/insight/0048-3486.htm

Poropat, A. E. (2009). A meta-analysis of the five-factor model of personality and academic performance. *Psychological Bulletin*, *135*(2), 322.

Primi, R., Santos, D., John, O. P., & De Fruyt, F. (2016). Development of an inventory assessing social and emotional skills in Brazilian youth. *European Journal of Psychological Assessment, 32,* 5–16.

Puustinen, M., & Pulkkinen, L. (2001). Models of self-regulated learning: A review. *Scandinavian Journal of Educational Research, 45*(3), 269-286.

Schneider, W. J., & McGrew, K. S. (2018). The Cattell-Horn-Carroll theory of cognitive abilities. In D. P. Flanagan & Erin M. McDonough (Eds.), *Contemporary intellectual assessment: Theories, tests and issues* (4th ed., pp. 73-163). New York: Guilford Press.

Snow, R. (1987). Aptitude complexes. In R. E. Snow S. & M. J. Farr (Eds.), *Aptitude, learning, and instruction: Volume 3: Conative and affective process analyses*, 11-34. Hillsdale, N. J. Lawrence Erlbaum Associates.

Snow, R. E. (1991). Aptitude-treatment interaction as a framework for research on individual differences in psychotherapy. *Journal of Consulting and Clinical Psychology*, *59*(2), 205.

Snow, R., & Farr, M. (1987). Cognitive-conative-affective processes in aptitude, learning, and instruction: An introduction. In R. E. Snow & M. J., Farr (Eds.), *Aptitude, learning, and instruction: Volume 3: Conative and affective process analyses*, 1-10. Hillsdale, N. J. Lawrence Erlbaum Associates.

Spearman, C. E. (1927). *The abilities of man: Their nature and measurement*. London: Macmillan.

VandenBos, G. R. (2007). *APA dictionary of psychology*. Washington, CD: American Psychological Association.

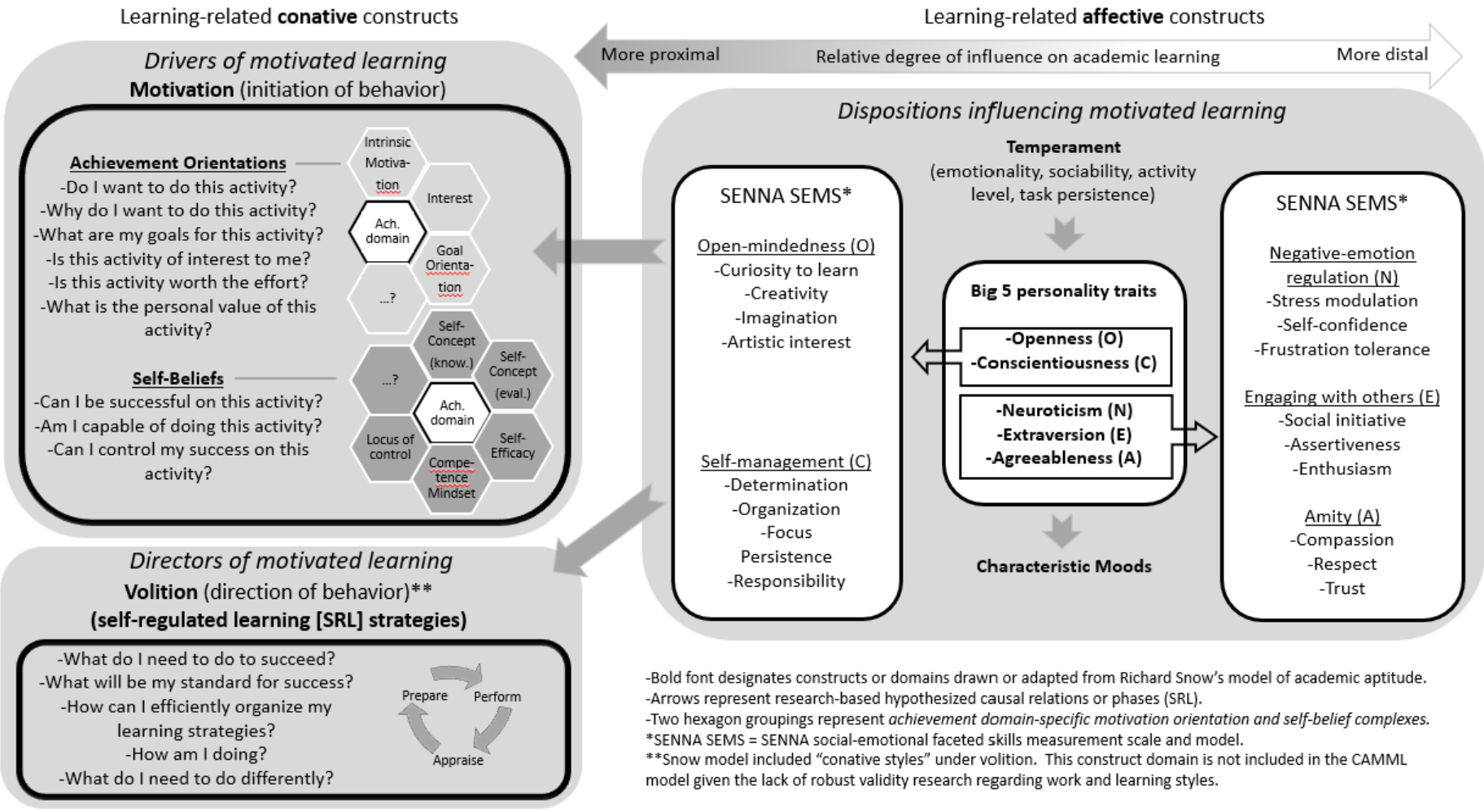
Vedel, A. (2014). The Big Five and tertiary academic performance: A systematic review and meta-analysis. *Personality and Individual Differences*, *71*, 66-76.

Wechsler, D. (1943). Non-intellective factors in general intelligence. *Journal of Abnormal and Social Psychology*, *38*, 101-103.

Zimmerman, B. J. (2001). Theories of self-regulated learning and academic achievement: An overview and analysis. in B. J. Zimmerman, & D. H. Schunk (Eds.), *Self-regulated learning and academic achievement: Theoretical perspectives* (2nd Ed., pp. 1-37). New Jersey: Lawrence Erlbaum.

Figure 1

The relations between affective and conative CAMML constructs.



-Bold font designates constructs or domains drawn or adapted from Richard Snow's model of academic aptitude.
-Arrows represent research-based hypothesized causal relations or phases (SRL).
-Two hexagon groupings represent *achievement domain-specific motivation orientation and self-belief complexes.*
*SENNA SEMS = SENNA social-emotional faceted skills measurement scale and model.
**Snow model included "conative styles" under volition. This construct domain is not included in the CAMML model given the lack of robust validity research regarding work and learning styles.

Figure 2

The CAMML Crossing the Rubicon model of motivated learning.