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REVIEW ARTICLE

Focusing the Conceptual Lens on Metacognition, Self-regulation, and Self-regulated Learning

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Abstract The terms metacognition, self-regulation, and self-regulated learning appear frequently in the educational literature and are sometimes used interchangeably. In order to explore the theoretical and empirical boundaries between these three constructs and the perceptions or misperceptions that their broad and often unqualified application may engender, an analysis of their use within contemporary research was undertaken. A PsychInfo database search was conducted and 255 studies were identified for a comprehensive data table. Analysis of these data revealed trends that suggest nesting of the constructs in definition and keyword explication. However, important differences emerged in the measures of these three constructs and in environmental factors such as prompting. Implications for future research are discussed.

Keywords Metacognition · Self-regulation · Self-regulated learning

> Everything that can be thought at all can be thought clearly. Everything that can be said can be said clearly.
>
> (Wittgenstein 1922/2003, p. 53)

In *Tractatus Logio-Philosophicus*, Wittgenstein (1922/2003) ideally and passionately argued that the powerful relation between thought and word demanded that language be used with great care and precision so that what is thought is expressed logically and with clarity. Although Wittgenstein came to rue some of the claims forwarded in this groundbreaking philosophical volume, his writings brought many to awareness that language, and more precisely the specificity of words, can have a profound effect on what is pondered and what is learned. Regrettably, there have been those who have decried the

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lack of linguistic clarity and specificity within the educational literature (e.g., Alexander *et al.* 1991, 2008; Murphy and Alexander 2000), where even our most central concepts and constructs, such as knowledge, learning, or motivation, are used with either the expectation that their meanings are well known and well accepted or without regard for the thoughts that engendered them or the thoughts that might ensue from their imprecise usage.

Of late, this concern about the clarity of meaning has become evident to us with regard to three often used and seemingly related terms, *metacognition*, *self-regulation*, and *self-regulated learning*. The triggering event in our exploration of these three terms was the emergent interest of the first and third authors in engaging in empirical research that involves individuals' monitoring and regulation of their learning and the concomitant inability to articulate sufficiently the conceptual boundaries between these three often entangled bodies of literature. In effect, the more we read, the more researchers' language left us confused. Further, it seemed from our cursory look into the literature that the rising popularity of self-regulation and self-regulated learning and the reemerging interest in metacognition added to the dilemma we were facing. Therefore, we chose to look deeper into the literatures on metacognition, self-regulation, and self-regulated learning; to focus our lens on these bodies of work in an attempt to sharpen the images presented and to bring a greater definition to the constructs alone and in association. We consider the disentangling of these terms as an important step to advance our programs of research on learner monitoring and regulation and those of others.

Due to the scope and complexity of this review, it is critical to establish its goals and parameters. Specifically, our focus is the core meaning of *metacognition*, *self-regulation*, and *self-regulated learning*, as well as where these constructs converge and diverge along select dimensions. The review is not intended to be a comprehensive or exhaustive examination of each individual construct, as excellent reviews in these areas have been undertaken by others for metacognition (e.g., Schwartz and Metcalfe 1994), self-regulation (e.g., Wigfield 1994), and self-regulated learning (e.g., Boekaerts and Cascallar 2006). Instead, we seek to extract the salient attributes of these constructs from the literature and to consider their potentially overlapping boundaries. Further, from our analysis, we wanted to identify significant issues affecting the definition and use of these constructs. To accomplish these two goals, it was essential for us to attend not just to the recent research in these areas, but to the theoretical and empirical roots of each. By tracing back to the empirical beginnings of metacognition, self-regulation, and self-regulated learning, we felt we could better understand how and why the conceptualization and operationalization of these terms evolved into their present-day manifestations.

Conceptual Roots and Conceptual Frames

Metacognition and self-regulation have unique roots within the psychological literature that must briefly be traced in order to contextualize the subsequent empirical analysis. This brief framing is complemented by Fox and Riconscente's (2008) in-depth and more philosophical survey of the writings of William James, Lev Vygotsky, and Jean Piaget that are foundational to the earlier psychological works we discuss.

Metacognition

Metacognitive monitoring emerged as a construct in the 1970s, stemming from writings on metaprocesses such as metamemory (e.g., Flavell 1971). In John Flavell's seminal writings

on metacognitive monitoring, he set the stage for this construct by describing the developmental aspects of how one monitors or thinks about one's own cognition. Flavell forwarded the conceptual definition of metacognition as "thinking about thinking" (e.g., Miller *et al.* 1970, p. 613). He went on to operationalize metacognition into four key areas: metacognitive knowledge, metacognitive experience, goals, and the activation of strategies. According to Flavell, the developmental process by which a person's metacognitive skills begin to grow or decline happens via the interaction of these four components, particularly metacognitive experiences. At a broader level, the foundation of metacognition is in the mind of the individual. Metacognition has been positioned in what Moshman (1982) labeled *endogenous constructivism*. That is, metacognition deals primarily with reflective abstraction of new or existing cognitive structures. In this sense, metacognition emphasizes learner development over learner–environment interactions.

Although the contemporary foundations for metacognition were laid by Flavell, he is not the only contributor to its conceptualization. For instance, Baker and Brown (1984), separated metacognition into two distinct elements: knowledge about cognition (monitoring) and self-regulatory mechanisms that contain monitoring as a central focus. The self-regulatory mechanisms included checking the outcome, planning, monitoring effectiveness, testing, revising, and evaluating strategies (Baker and Brown 1984). The focus on strategic control processes was further developed into what some have called *metacognitive control processes* (e.g., Nelson *et al.* 1992). With the incorporation of self-regulatory metacognitive mechanisms, we begin to see some confound with the construct of self-regulation, as metacognition began to gradually diverge and expand from Flavell's original conceptualization.

Self-regulation (SR) and self-regulated learning (SRL)

Contemporary self-regulation has been heavily influenced by the work of one scholar whose initial writings were published in the 1970s. Albert Bandura's (1986) *Social Foundations of Thought and Action* helped to shape the direction and development of self-regulation. Compared to the clearly cognitive orientation in metacognition, self-regulation initially emphasized behavioral and emotional regulation (e.g., Bandura 1982, 1989). With Bandura's later writings on self-efficacy, motivation emerged as an additional regulatory area.

Further, Bandura (1977) described human functioning as the *interaction* between person, behavior, and environment. Specifically, self-regulation emphasizes the reciprocal determinism of the environment on the person, mediated through behavior. Person variables include the distinct *self* processes that interact with the environment through one's actions. For example, Bandura's self-reinforcement processes in Social Learning Theory (SLT) are predominately motivational. These motivational dimensions include evaluative dimensions of performance, personal standards, valuations of activities, and attributions. However, the act of self-regulation does not occur without the interaction of the person with the environment. Although these contextual factors may play a smaller role than the person processes, these interactions are critical to the self-regulation process. This theoretical focus appears different than with metacognition, involving a type of *exogenous constructivism* (Moshman 1982). Specifically, in SLT, the emphasis is placed on the derivation of knowledge from the environment. Moreover, while Flavell and metacognition researchers appear to have been more influenced by the cognitive orientation of his predecessors (e.g., Jean Piaget), Bandura and other self-regulation researchers appear to have been more influenced by neobehaviorism (e.g., the writings of Kenneth Spence), which takes its cues from more empiricist frameworks (Byrnes 1992).

Since the publication of Bandura's classic volume, self-regulation has continued to develop. For instance, of particular interest to this review is the emergence of SR research in academic domains by Zimmerman, Schunk, and colleagues (e.g., Zimmerman and Schunk 2001). Others, such as Graham and Harris (e.g., Graham *et al.* 1991) have provided a finer-grained analysis of self-regulation in their examination of SR strategies in academic domains such as writing.

The increased focus on self-regulation in academic settings appears to have directly contributed to the emergence of a new term, *self-regulated learning* or SRL. SRL emerged in the 1980s and gained prominence in the 1990s, just as the work on hypermedia was becoming a growing presence in the educational literature. The developmental path of SRL is quite different from the trajectories of metacognition and self-regulation. Specifically, while metacognition and SR developed in parallel with little observable cross-fertilization, most models of SRL incorporate aspects of both metacognition and self-regulation to shape its lens on learner monitoring. Theorists initially posited SRL as an integrated theory of learning (Corno and Mandinach 1983), deliberately attempting to address the interaction of cognitive, motivational, and contextual factors rather than their isolated contributions. Unlike the beginnings of metacognition and self-regulation, the regulatory focus was relatively broad.

The broader regulatory focus in SRL integrates both *endogenous* and *exogenous* theories into one that Moshman (1982) described as *dialectical constructivism*. In SRL, "neither exogenous learning nor endogenous development is, in this view, predominant over the other: The two exist in a relation of reciprocal constraint and facilitation," (p. 375). Byrnes (1992) pointed out that fusing these theories is possible, since they are not mutually exclusive. Byrnes also noted that integrated views were increasingly sought, just as SRL began to gain in popularity. As we will see in the analysis that follows, this wide scope of SRL comes with positive *and* negative consequences in the empirical research.

Method

Search criteria

In order to consider the state of metacognition, SR, and SRL in contemporary educational psychology literature, we created three study pools corresponding to the three constructs. These three pools were developed by searching PsychInfo using the keywords, *metacognition*, *self-regulation*, and *self-regulated learning*, in separate searches. The keywords were not limited to title or abstract, in order to include all potentially relevant studies. Due to the vast number of studies initially identified by these search parameters, we limited the search to empirical works published in the past 5 years (2003–2007).

In addition, we hand searched the following journals to identify any suitable publications: *Contemporary Educational Psychology*, *Educational Psychologist*, *Instructional Science*, and the *Journal of Educational Psychology*. In the hand search, we examined the last 5 years of each journal and scanned the titles and abstracts to find any potential studies that may have been missed in the database search. In addition, we identified some newer publications that were not available through either the database search or a physical hand search. For example, the journal *Metacognition and Learning* was first published in 2006, and was not available in the database search, so it was added to our hand search.

Lastly, in order to make relevant comparisons between these constructs, we limited studies to those in which academic learning or school performance was considered. By

academic learning, we refer to all school-related subjects (e.g., mathematics, science, reading, music, or physical education). Academic learning in these studies could either occur in naturalistic settings (e.g., the classroom) or in more contrived settings (e.g., the laboratory). The academic learning criterion significantly reduced the number of studies overall, but had differential effects on the final selection of documents for the three constructs. For instance, with metacognition, a number of excluded studies focused on clinical applications, such as work with alcohol abusers (e.g., Hoyer *et al.* 2007) and the clinical treatment of attention deficit/hyperactivity disorder or ADHD among children (e.g., Knouse *et al.* 2006). Studies that were retained in the metacognition pool dealt broadly with academics whether in school (e.g., Jacobs 2004) or out of school (e.g., Metcalfe and Kornell 2005). Like metacognition, most excluded self-regulation studies pertained to clinical behaviors or undesired psychological habits, such as eating disorders or smoking behaviors. Additionally, SR studies dealing with personality factors or personality disorders, such as phobias or emotional effects of traumatic brain injuries, were not considered in this analysis.

Least affected by the academic learning criterion was SRL. Since SRL has generally been conceptualized to involve regulation within academic domains, most of those studies were retained. However, since we excluded studies of participants with clinically diagnosed problems for both metacognition and self-regulation, we also excluded studies in SRL, although they were rare (e.g., Reid and Lienemann 2006). After inclusion criteria were set, we were still left with an impressive number of studies for all three constructs. The resulting pool included 255 studies (i.e., 123 metacognition, 54 self-regulation, and 78 self-regulated learning articles).

We organized studies into a comprehensive table with three designated sections corresponding to the constructs (i.e., metacognition, self-regulation, and self-regulated learning). Studies within the table were organized first by year of publication and then alphabetically by authors. We analyzed each article according to the following: definitions of the constructs, measures used, measurement method (e.g., self-report), and instances of priming or cueing during a task. Due to its size and complexity, the full summary table is not provided in this article but can be accessed online (see Supplementary Table).

Analyzing the studies in this manner proved difficult for three reasons. The first two reasons pertained directly to the way in which studies are coded via keywords in the PsychInfo database, while the third issue related to the attention to multiple constructs within the investigations. First, the extent to which each study identified through our search parameters dealt expressly with any of the three constructs of interest proved problematic. Specifically, even though a given study was keyed to a particular construct within the database (e.g., self-regulated learning), the particular construct was neither defined nor measured in the study. In certain instances, the terms *metacognition*, *self-regulation*, and *self-regulated learning* may have been chosen by authors as a keyword for article cataloguing or one or more of these terms were mentioned peripherally in the theoretical framing or discussion. But in neither case was that keyed term the construct under investigation. For instance, Lizzio and Wilson's (2005) study was identified through our self-regulated learning search. In this study, self-regulated learning was not a construct of interest and only a passing reference was made to self-regulatory strategies in the discussion and conclusions.

Second, many of the studies identified by the search parameters in PsychInfo actually referred to a different construct than the one keyed in the database. This concern seemed most evident for studies dealing with either self-regulation or self-regulated learning. For example, an article by Mason (2004), dealing with the self-regulated strategy development

(SRSD), was identified through our self-regulated learning search. Yet, self-regulated learning per se was never explicitly defined or measured. Rather, the focus was on the SRSD as a strategy for teaching self-regulation to those with academic difficulties. Other studies of SRSD (e.g., Harris *et al.* 2006) were more accurately identified via keywords as part of the self-regulation search. For such problematic studies, we relied on the contents of the investigation, rather than the keywords in the database, to position it within the appropriate section in the review table.

Third, some studies defined and measured more than one of the constructs of interest. Although this problem was most salient with self-regulation and self-regulated learning, this issue occurred across all three constructs: metacognition and SR (e.g., Aleven *et al.* 2006; Marchand and Skinner 2007), metacognition and SRL (e.g., Nietfeld *et al.* 2005; Vandergrift 2005), and SR and SRL (e.g., van Grinsven and Tillema 2006). This issue seemed to be a direct result of the absorption of both metacognitive monitoring (e.g., feelings of knowing) and the motivational aspects of self-regulation (e.g., self-efficacy) in SRL studies. Our solution for this construct overlap was to determine which construct was more prevalent in both its definition (if provided) and the measures employed. Studies of SR and SRL were often very similar in both their terminology and measurement and would define both constructs. However, if the study contained a measure such as the Motivated Strategies for Learning Questionnaire (MSLQ) we included it as part of the self-regulated learning section of our table, since the MSLQ was more typical of SRL studies. Thomas and Gadbois's (2007) study was illustrative of this coding issue.

Coding scheme

Due to the large number of studies and the difficulty of differentiating between them for certain dimensions, we felt that an explicit scheme was essential to ensure that resulting codes were reliable and valid. Thus, we developed two broad categories of codes for each construct: definitions and measurement. Within the category of definitions, we identified the extent to which authors explicitly defined the target constructs and identified trends in definitional emphasis. For the category of measurement, we coded the data sources (e.g., self-report or interview) and the alignment of definition to measurement, that is, the correspondence between conceptual and operational definition. Lastly, we examined studies to determine the level of prompting or cueing in the experimental task or environment. For the table and the coding, we engaged in extensive discussion to ensure that the codes were consistent. In addition, initial codes underwent modification early in the process to accommodate the diversity we encountered in the literature. Once issues with the coding scheme were resolved, the first and third authors classifying all identified studies with a high level of interrater agreement ($\alpha > 0.85$)

Clarity of definitions Our first step was to code the clarity of the definition provided in each study. Two broad categories of definitions were identified, explicit and implicit. When we modeled this scheme from the Murphy and Alexander (2000) review, we had also anticipated a third definitional category, "absent," to apply when explicit or implicit codes were deemed inappropriate. However, no such entries appeared in our final analysis and, therefore, this third category was dropped. Explicit definitions provided by the authors are italicized in the table and coded as an E in the definitional codes column. For example, Nietfeld *et al.* (2005) defined metacognition as having, "two components: knowledge about cognition and regulation of cognition. Monitoring falls under the regulation facet of

metacognition and refers to one's awareness of comprehension and task performance while in the process of performing a specific task" (p. 9).

In addition to identifying explicit definitions, we also coded the various forms of implicit definitions found in these studies. Three forms of implied definitions were identified: conceptual definitions (C), where authors do not expressly state a definition but where words or phrases appeared in the text that alluded to meaning; referential definitions (R), where key references were applied as proxies for definitions; and measurement definition (M), where measures alone served as definitional markers. For instance, although Hole and Crozier (2007) never explicitly defined self-regulation, there was mention in the text of task persistence, cognitive engagement, help-seeking and choice of a future task as qualities associated with self-regulation. We, thus, coded those words as indicative of the author's conceptualization of self-regulation (C). In contrast, Efklides and Petkaki (2005) did not explicitly define the term *metacognition*, but provided a reference to Flavell's seminal writings, which we coded as a referential definition (R) for that construct. In some cases, authors implicitly signaled their definitions conceptually *and* referentially. For instance, Burton *et al.* (2006) characterized *self-regulation* as intrinsic and identified motivation, and also referred the reader to Deci and Ryan's (1985) writings on the construct. We identified these cases with dual codes (C/R). Further, we used the measurement (M) code only when no explicit, conceptual, or referential definitions were provided. For instance, Bråten and Strømsø (2005) did not provide an explicit definition for *self-regulated learning*, but operationalized it through the use of the Motivated Strategies for Learning Questionnaire. All implied definitions were identified in the definitional codes column of table as an *I* along with a sub-code that depicted the type of implied definition (i.e., C, R, or M).

Definitional emphasis The second focus of our definitional coding scheme centered on the common words or phrases that authors used to define the construct(s) of interest. For the explicit definitions only, we looked at words used expressly by the authors. Our intention was to investigate the shared language or common phraseology that might frame each construct within the literature. We assumed that the presence of such a common lexicon would signal a more accepted view of these latent constructs within the research community.

Operationalization of definitions In order to understand construct operationalization within each study better, we listed the type of measurement used (e.g., self-report) in data gathering. Next, we identified the degree to which the construct definition provided by the author aligned to the measurement. In this endeavor, we used four types of codes: clear match between the definition and measure (F); partial match between the definition and measure (P); or an ill or poor match between the definition and measure (I). For example, if the construct was defined as metacognitive knowledge, as in the van Gog *et al.* (2005) study, and metacognitive knowledge was what was actually measured—whether by researcher-designed or commercially available measures—we coded that as a clear match. If the study only measured part of the forwarded definition, we coded that as a partial match. For example, the Hofer *et al.* (2007) study of self-regulation included a cognitive component in the definition, but did not include a dedicated measure of cognitive processes. Lastly, if the match between the definition and the measure was unclear or non-existent, we coded this as an ill-match. For example, in Al-Hilawani's (2006) study, it was unclear how the definition of metacognition and the experimental picture task were related.

In some cases, we were unable to identify a match between the definition and the measure. This occurred for two reasons. First, for cases with implied measure definitions, such as the Bråten and Strømsø (2005) study noted earlier, the researcher only defined the

construct through the measurement parameters. Thus, it was impossible for us to align the definition to the measure, as they were one in the same. In these cases, the alignment code column was left blank.

The second case for which alignment coding proved troubling occurred for studies incorporating treatment or training. In these instances, subjects were taught to use metacognition, self-regulation, or self-regulated learning strategies in classroom or laboratory contexts. A common example of this type of study was self-regulated strategy development training (e.g., Mason 2004), where subjects were taught self-regulation strategies to improve writing or reading performance. While many of these studies provided clear, explicated definitions of terms, some did not have a dependent measure of the construct due to the experimental design. Instead, the overall treatment condition was measured through analysis of some other dependent measure, such as writing or reading performance. Again, for these cases, the alignment code column of the table was left blank.

Prompting and cueing Due to the co-emergence of self-regulated learning and hypermedia, studies in our analyses, especially for SRL, occasionally involved tasks with built-in prompts or cues. In the literature, prompting or cueing is often referred to as scaffolding. Some, such as Azevedo *et al.* (2005) have delineated three classes scaffolding: fixed scaffolding, adaptive scaffolding, and no scaffolding. In fixed scaffolding, the prompts do not change relative to the learner's performance. These prompts are the same for each participant. Adaptive scaffolding, as the name implies, changes based on some form of input from the learner. For example, if the learner is performing well, prompts may not be given, whereas, if the learner is performing poorly, prompts are provided or enhanced. Lastly, there is the no-scaffolding condition, where prompts are not present at all. These three levels of prompting are provided by both humans and computers in the literature. We applied the Azevedo *et al.* scheme in this analysis to indicate whether fixed scaffolding (FS), adaptive scaffolding (AS), or no scaffolding (NS) was provided. Further, for studies that included fixed or adaptive scaffolding, we coded instances as human (H) or computer (C) prompting.

General Trends and Emerging Concerns

Once our search of the recent literature and the coding of resulting studies had been reliably accomplished, we set out to discern any relevant patterns within these data that pertained directly to construct definition, construct measurement, or other empirical or educational issues. In some instances, we perceive these patterns as interesting but not necessarily problematic trends within these growing literatures. In other cases, however, we feel that the pattern merits more concern among researchers who are pursuing this line of inquiry.

Explication of definitions

In order to extract the salient attributes of metacognition, self-regulation, and self-regulated learning from the literature, we investigated the degree to which researchers explicated those terms. The underlying assumption that we made in this analysis was that explicit definitions are more desirable than implied definitions because the reader is not left to infer the meaning of the term. When definitions are implied through allusion to meanings of specific words or phrases in the text (i.e., conceptual), by citation to key referents (i.e., referential), or through measurement parameters (i.e., measurement), the onus is on

consumers of that research to extrapolate the authors' intended meaning of the construct. Such a burden would be questionable when terms have a set or common meaning among researchers or practitioners, but it may be even a more precarious venture for fields like education for which the lexicon can be amorphous and open to interpretation (Alexander *et al.* 1991). In such instances, confusion or misinterpretation of the construct may arise.

In our review of the literature, we considered explication of definitions across and within constructs. Across constructs, we found that 49% of target terms were explicitly defined by the researchers, while 51% of target terms were implicitly defined. As shown in Table 1, implied definitions were further described as either conceptual or referential, or defined by measurement. Frequency and relative percent of implied definitions by construct is provided in Table 1. Trends emerged in explicit definitions, implicit definitions, and explicit definition keywords.

Of interest was the proportion of explicit definitions provided within each construct. Explicit definitions occurred more frequently in the self-regulation (31/54; 57%) and self-regulated learning literatures (54/78; 69%) than in the literature on metacognition (39/123; 32%). We can forward three possible explanations why there is less explication of *metacognition* within the literature. First, as we alluded to earlier, SR and SRL have closer ties to neobehaviorism, where the requirement to provide explicit operational definitions is more common. Second, perhaps researchers assume that *metacognition* is a rather well-established term that needs no further clarification beyond a suitable citation. In contrast to the relatively complex interaction of behavior, cognition, and motivation emphasized in the SR and SRL literature, there is a deceptively simple conceptualization of metacognition such as "thinking about thinking." Third, it is also possible that there is more theoretical diversity represented in the SR and SRL research as compared to the more clearly cognitive perspective signaled by metacognition. Thus, researchers in SR and SRL find the explicit definition of their constructs a means to align their research with a particular segment of the literature be it more social cognitive, as in the writings of Zimmerman and Schunk (2001), more cognitive behavioral modification for Graham *et al.* (2007), or more information-processing, as in the work of Azevedo and colleagues (e.g., Azevdeo and Cromley 2004). However, regardless of the reasoning, reliance on implicit definitions is a concern.

Within the category of implicit definitions, two additional trends were revealed. One notable observation was the low frequency of referential definitions across constructs. It was more common for referential definitions to be presented in combination with conceptual allusions to meaning (i.e., I-C/R notation) rather than to find referent-only definitions. This finding was promising because, although the authors did not provide explicit definitions, they did supply multiple opportunities for the reader to infer meaning.

Table 1 Frequency and Relative Percent of Implied Definitions by Construct

Definitional category	Construct					
	Metacognition		Self-regulation		Self-regulated learning	
	f	Percent	*f*	Percent	*f*	Percent
Conceptual	40	48	07	30	07	29
Referential	08	10	00	00	03	13
Conceptual/referential	23	27	09	39	05	21
Measure	13	15	07	30	09	38

A second interesting finding related to definitions that were inferred from measures. Of the studies that provided implied definition, self-regulation (38%) and self-regulated learning (30%) were more likely than metacognition (15%) to be defined only by the parameters of measures. This finding is particularly interesting in light of the relatively high proportion of explicit definitions of *self-regulation* and *self-regulated learning.* Specifically, these data suggest almost a feast or famine of definitional clarity in the SR and SRL literatures. That is, researchers were either very meticulous in defining their core constructs or relied on the weakest mode of definition for self-regulation and self-regulated learning, namely the measure or measures selected.

Another notable trend occurred in the repetition of keywords in explicit definitions. Seven words were routinely found in explicit definitions across the three constructs. Specifically, the keywords were *monitor*, *control*, *regulate*, *cognition*, *motivation*, *behavior*, and *knowledge*. Variants of keywords were included in the analysis (e.g., *behaviors* or *behaving*). The percent of keyword occurrences within each construct is presented in Table 2. The percentages and frequencies refer to the number of studies in which the keyword appeared in the explicit definition. We elected not to code the nesting term *cognition* for *metacognition*, or the word *regulation* for either *self-regulation* or *self-regulated learning*. Two notable patterns emerged in these data. First, the keywords in explicit definitions revealed differential research emphases for each of the constructs. Specifically, explicit definitions of self-regulation and self-regulated learning were broadly focused, as evidenced by the high proportions of *cognition*, *motivation*, and *behavior* keywords. Conversely, explicit metacognition definitions were more narrowly constrained within the cognitive realm, with minimal instances of *motivation* or *behavior* as keywords. These data made sense in light of our discussion of the historical roots of these three constructs.

Second, the frequency of word choice across the constructs suggested a conceptual overlap. Specifically, the explicit words and phrases associated with *self-regulation* and *self-regulated learning* were quite similar. Both construct definitions frequently referenced *behavior*, *motivation*, *cognition*, *monitoring*, and *control*, but the word *knowledge* was far less evoked. Further, proportions of these keywords were relatively comparable for SR and SRL. The pattern of emphasis may suggest a nesting of the two constructs. Specifically, these data might suggest that SRL may be a special case of self-regulation (i.e., self-regulation in an academic context). Nesting of metacognition with self-regulation and self-regulated learning might also be inferred from these data. In fact, the keywords *monitor* and

Table 2 Frequency and Percent of Keywords in the Explicit Definitions by Construct

Definitional category	Construct					
	Metacognition		Self-regulation		Self-regulated learning	
	f	Percent	*f*	Percent	*f*	Percent
Monitor	20	51	11	35	21	39
Control	19	49	12	39	18	33
Regulate	17	44	–		–	
Cognition	–		15	48	23	43
Motivation	01	03	13	42	27	50
Behavior	02	05	13	42	21	39
Knowledge	23	59	02	06	08	15

control appear with similar frequency across the three constructs. Although the two terms are most obviously associated with Flavell's (1979) description of metacognition, these results suggest that monitoring and control are likewise conceived as an aspect of self-regulation and self-regulated learning. Further evidence of this conceptual overlap can be found from data collected using instruments measuring both metacognition and self-regulated learning (Sperling *et al.* 2004; for a further discussion of this issue, see Veenman 2007). Differences between metacognition, SR, and SRL may lie in *what* is being monitored or controlled. In self-regulation and self-regulated learning, monitoring or control may refer to behavior, cognition, or motivation, while metacognition likely emphasizes monitoring and control of cognition, specifically.

The high percentage of implied definitions, overlap of explicit definition keywords, as well as the potential nesting of constructs, contributed to the difficult task of organizing data by construct. The challenge we experienced in attempting to untangle these three constructs indicated that the clarity and boundaries of these constructs were issues to be addressed.

Definition and measurement alignment

Perhaps the most difficult task for us was aligning the explicit and implicit definitions forwarded by researchers with the measures they used. The measurement alignment across the three constructs is presented in Table 3. Overall, these data suggest that the definitional measurement alignment was better for the SRL literature than for studies of metacognition and self-regulation, which produced similar alignment patterns. Specifically, more than 92% of the SRL studies evidenced full alignment between what was defined and what was measured, as compared to 71% and 63% full alignment for metacognition and self-regulation studies, respectively.

However, these data and the coding scheme we employed may not tell the complete story. We also found issues of measurement clarity, scope, type of measurement, and scaffolding. First, as with the definitional clarity, there was noticeable variability in the degree to which measures were explicated by researchers. Often, we struggled to identify exactly what was being measured, particularly when authors created their own instruments and when only one or two items from those researcher-designed measures were provided in text. In such cases, there was no way to ascertain whether the sample items were representative of the measure as a whole.

Also, if the definition itself had to interpreted, we were forced to make two interpretations of these data to try to judge the conceptual–operational link. Second, since we found evidence in these data that these constructs are nested, comparisons between

Table 3 Percent Alignment of Definition to Measures by Construct

Definitional category	Construct					
	Metacognition		Self-regulation		Self-regulated learning	
	f	Percent	*f*	Percent	*f*	Percent
Full	76	71	24	63	60	92
Partial	21	20	09	24	5	08
Ill	10	09	05	13	0	00

constructs were difficult to undertake. The scope of SRL was quite large and typically the measures of SRL were also broad, often involving general measures of academic behavior. For example, many of the SRL studies included in this review relied on the MSLQ (Pintrich *et al.* 1991). The MSLQ is a self-report measure that includes motivation scales tapping into students' values, expectancies, and affect, and a learning strategies section that surveys students' use of cognitive, metacognitive, and resource management strategies.

Types of measures

The types of measures used in the studies from our table varied widely. Six types of measurements were documented in our coding. Those types of measurement were: self-reports, observations, think-aloud protocols, interviews, accuracy ratings, and diaries. From our examination of these data, it is clear that self-report was the dominant type of measure for all three of these constructs, at nearly 43%. However, different patterns emerged when the constructs were examined separately (see Table 4).

As suggested, the reliance on self-report was much greater for SRL and SR. Although the argument could be made that the accuracy ratings (e.g., judgments of learning or JOL and feelings of knowing or FOK) are also self-reports, these measures differed in one key aspect from the classification of self-reports in our coding scheme. Specifically, when accuracy ratings were used, they were used in conjunction with an experimental task (e.g., a vocabulary task). This key difference in measurement (task involvement) not only contextualized learners' estimation of their cognitive ability, but also typically involved a posttest to correlate performance estimates with actual outcomes. To us, it seems unlikely that isolated or decontextualized self-reports for SR and SRL studies would uncover the complex interactions that are at the heart of the conceptual definitions that frame these literature. Rather, it would seem that additional evidence would be needed or corroborate individuals' monitoring or regulatory reports, especially when researchers are attempting to make causal claims related to these constructs.

Prompting and cueing

The co-emergence of SRL and computer-based learning environments (CBLEs), such as hypermedia, has introduced an added layer of complexity in many of these studies. Often, this layer of complexity in CBLEs involves some type of prompting or cueing, often referred to in the literature as scaffolding. As described in the "Method" section, we not

Table 4 Frequency and Percent of Measurement Type by Construct

Measurement type	Construct					
	Metacognition		Self-regulation		Self-regulated learning	
	f	Percent	*f*	Percent	*f*	Percent
Self-report	29	24	37	73	44	59
Observation	24	20	10	20	12	16
Think-aloud	14	12	00	00	10	13
Interviews	16	13	02	04	07	09
Performance ratings	38	31	01	02	02	03
Diaries	00	00	01	02	00	00

Table 5 Frequency and Percent of Scaffolding Type by Construct

Scaffolding type	Construct					
	Metacognition		Self-regulation		Self-regulated learning	
	f	Percent	*f*	Percent	*f*	Percent
Fixed	15	17	00	00	12	28
Adaptive	13	14	01	11	14	33
Combination	00	00	01	11	02	05
None	45	50	00	00	07	16
Training	17	19	07	78	08	19

only wanted to document the presence of scaffolding in studies, but also the source of that scaffolding. Specifically, we coded whether scaffolds were provided by humans, computers, or some combination thereof. Often, even in situations where monitoring or regulatory data were self-reported, there was some type of training or intervention occurring for metacognitive or self-regulatory skills. For example, in Mason's (2004) study, strategy training was provided in the classroom. In such cases, we had to infer the presence of scaffolding. We made that judgment based on the description of the training or intervention included in the methods section of each study.

The frequency and percent of studies that used fixed scaffolding, adaptive scaffolding, no scaffolding, or training are displayed in Table 5. The breakdown of those scaffolded studies according to the source of the prompts and cues is shown in Table 6. The most obvious trend in the data is the limited presence of scaffolding in self-regulated studies. This outcome likely reflects the infrequent reliance on experimental or performance tasks in these studies. However, for metacognition and SRL, which both had a greater number of studies involving experimental or performance tasks, important differences were evident in the data. One interesting trend we noted was the comparable reliance on computer and human scaffolding for both metacognition and SRL (for a more in-depth discussion of SRL and hypermedia, see Winters *et al.* 2008). Because a substantial number of SRL research involved hypermedia, we had expected a higher presence for computer scaffolding in this literature.

For us, the presence of scaffolding in the environment, whether computer based or not, presents a potential confound in the results regarding these constructs, particularly that of SRL. Because there was little evidence in these studies that the task scaffolds were systematically faded or removed over time, as would be expected of cognitive behavior

Table 6 Frequency and Percent of Scaffolding Source by Construct

Scaffolding type	Construct					
	Metacognition		Self-regulation		Self-regulated learning	
	f	Percent	*f*	Percent	*f*	Percent
Computer	16	57	00	00	13	48
Human	11	39	01	50	12	44
Combination	01	04	01	50	02	07

modification or CBM studies like those of Graham and Harris (e.g., Graham *et al.* 2007; Harris 1986), and without the inclusion of delayed posttesting or transfer tasks that suggest enduring changes in monitoring or regulation, it is difficult to tell if these scaffolds, which are cases of other-regulation, actually translate into instances of self-regulation.

Final Frames: What was Seen and What Remains to be Seen

We began this review with the inspiring yet unnerving words of Ludwig Wittgenstein who cautioned all who would listen to regard the power of language. For those of us who have dedicated our lives to the education of others and to the empirical study of human learning and development, there is no avoiding the fact that there is a relation between clarity and precision of language and the ideas that take shape in the mind. Despite Wittgenstein's proclamation that "everything that can be said can be said clearly" (1922/2003, p. 53), we do not believe that language, even the language of research, can be completely disambiguated. Nonetheless, we would concur that there are many instances when researchers in this domain contribute to the conceptual haze that blurs their messages and confounds their educational mission. We engaged in this systematic review of the literatures in metacognition, self-regulation, and self-regulated learning with the expressed hope that we would be able to lift the conceptual haze and, to some extent, locate areas of construct clarity. There were, indeed, outcomes of this detailed analysis that left us optimistic, but other trends failed to alleviate prior concerns or raised more questions.

The conceptual core

Even though there are distinct histories to the literatures on metacognition and self-regulation, and a still emerging presence to self-regulated learning, we found important commonalities in the words and phrases used explicitly and implicitly by the authors to define these terms. These commonalities reveal an undeniable conceptual core binding the three constructs, namely, that individuals make efforts to monitor their thoughts and actions and to act accordingly to gain some control over them. It is, in effect, a marriage between self-awareness and intention to act that aligns these bodies of work.

Yet, it should not be assumed that the conceptual core serves as justification for the treatment of *metacognition*, *self-regulation*, and *self-regulated learning* as synonymous terms or conceptual givens. To the contrary, it requires those in the educational research community to be even more vigilant in their attributions and delineations: To mean what they say and to say what they mean. Beyond their shared core, there are conceptual distinctions or differences that researchers must acknowledge if they are to choose the appropriate construct to address their research question. Further, careful explication of the construct would go a long way to lifting the conceptual haze that overlays these related literatures.

Points of convergence and divergence

Throughout this review, we made reference to "nesting" or "overlap" when describing the associations between metacognition, self-regulation, and self-regulated learning. We want to focus more on these perceived associations and our evidence for those perceptions. As we progress in this discussion, however, it is imperative to remember that conceptions of these constructs are not stagnant or fixed, rather they continue to move and take shape over

time. When first conceived, for instance, metacognition and self-regulation reflected the varied theoretical roots of their progenitors. Flavell and colleagues (e.g., Miller *et al.* 1970) were developmental psychologists who were most concerned with how individuals' awareness of their thoughts took form through maturation and experience, whereas Bandura (1977) was especially interested in the person–environment–action dynamic in his articulation of self-regulation. Thus, in these roots, we see a clear cognitive orientation for metacognition, while self-regulation is as much concerned with human action than the thinking that engendered it. Incidentally, neither Flavell nor Bandura was especially dedicated to the role of these processes in learning or in academic contexts. That implication and application would come from others who carried these constructs into academic domains (Zimmerman and Schunk 2001) and into classrooms (Graham *et al.* 1991).

When we look at metacognition and self-regulation today, we can still catch glimpses of their varied roots. However, we can also see how those roots became increasingly entangled. Specifically, as the prominence of metacognitive strategies grew and the relation between self-awareness and cognitive response took hold, metacognition began to venture into the realm of behavior more associated with self-regulation. Moreover, when self-regulation began to target the cognitive realm rather than the psychosocial or behavioral domains, its correspondence to metacognition became increasingly pronounced. What remains to us as a distinction, however, are the differential emphases on the role of the environment. For many self-regulation researchers, it is the environment that stimulates individuals' awareness and their regulatory responses. In contrast, those researching metacognition look to the mind of the individual as the initiator or trigger for subsequent judgments or evaluations.

When we factor in the newest member of this regulatory triad, self-regulated learning, there are additional entanglements that must be addressed. For one, what distinguishes SRL from its predecessors is its exclusive focus on academic learning. Unlike metacognition or self-regulation, SRL did not find its way into the classroom or academic realm, it began there. Though the term "learning" more narrowly focused this construct, it also resulted in dual interpretations of its meaning. Specifically, we came to the conclusion through this review that there are actually two classes of SRL research. There are those individuals who are actually engaged in self-regulation research but who affix the word *learning* to situate the work within the academic domain. By contrast, there are those for who self-regulated learning has more to do with the person–environment interaction, where the computer is a key to task delivery and to the scaffolding providing during task performance. The other observation to be made about self-regulated learning as a body of work is that there is the intention, especially among those who involve hypermedia, to bring elements of metacognition and self-regulation together, that is, intention to span both research traditions.

The measurement conundrum

One of the troubling issues that we must confront from this analysis is the nature and quality of the measures that were plied to uncover individuals' monitoring or regulatory behaviors. First, it would seem to us that efforts to bring precision to the language of metacognition, self-regulation, and self-regulatory learning would remain a somewhat hollow enterprise if there is not a concomitant effort to find more precise measures of such processes. Sadly, in our survey of the research, we found that there remained a strong reliance on self-report and Likert-type instruments and insufficient corroboration or collaboration of what individuals report they are thinking or doing with actual traces of

such thoughts or behaviors (cf. Winne and Perry 2000). Further, it is unclear how very broad-brush measures that seek to generalize across multiple times and situations, as well as across cognitive, motivational, emotional, and behavioral domains, can fairly and accurately gauge monitoring or capture the dynamic interplay of person, environment, and behavior that is the hallmark of self-regulation.

With the advancements in technology and with the acceptance of multimethod studies, we have the opportunity to go wider and deeper in our examinations of monitoring and regulation. We have the chance, as Winne and colleagues are doing, to build tasks that may not only instigate awareness, reflection, or regulation, but that will also document subtle moves and actions with minimum intrusion. Similarly, there is the opportunity to use more ethnographic or phenomenological techniques to probe the thoughts, explanations, and justifications of those who are engaged in academic tasks for which monitoring or regulation would be anticipated. It may be that neither quantitative nor qualitative approaches alone will suffice to illuminate the nature of monitoring and regulation, but that some combination is required.

Development and longitudinal studies

When Flavell and colleagues began to explore metacognition, they were particularly interested in how this process of thinking about thinking emerged in young children. Yet, it was surprising to us that, in this review, questions about development, particularly in relation to self-regulation and self-regulated learning were relatively rare. Due to its developmental roots, metacognition has dealt more so with developmental aspects (e.g., Alexander *et al.* 2003; Veenman and Spaans 2003), but researchers are still seeking to ascertain who monitors or regulates and when, what types of environments stimulate monitoring and regulation, and how monitoring and regulation are tied to academic performance. As valuable as these questions are, it would seem equally important to ask whether the nature of monitoring and regulation changes over time not only through maturation but also as a consequence of changing knowledge, interests, goals, and experiences. It would also be important to know whether there is a propensity to be monitoring or self-regulating, or if such processes are more likely triggered by conditions within the immediate environment. There is also the question of generalizability or transfer of such processes. In effect, what is the evidence that the prompting and cueing we witnessed in many studies can be faded or eliminated, eventually being replaced by internal triggers or "habits of mind"? What is required to turn "other" regulation into "self" regulation, for instance? These are just a few of the developmental questions that cannot be answered by cross-sectional or short-term investigations, even when the constructs in those investigations are nicely explicated, the measures well aligned, and the data competently analyzed.

Degrees of separation

There is no question that there is a rich and growing literature related to metacognition, self-regulation, and self-regulated learning. Even when we constrained our current examination to the academic realm, we were faced with the daunting task of analyzing and synthesizing well over 200 documents. We had hoped that this endeavor would bring us (and perhaps the broader educational community) closer to comprehending the nature and associations between these three vital programs of research. Yet, we cannot conclude without acknowledging the risks inherent in this undertaking. Part of that risk comes as programs

of research continue to migrate and mature, moving progressively away from their roots and progenitors. Should we expect to hold current generations to the conceptions first framed by Flavell, Bandura, and others, or is it assumed that alternative and contemporary conceptions are warranted?

We faced another risk in the inferences that were frequently required when necessary details were absent or underspecified. It was not simply that the definitions guiding the research had to be construed from whatever evidence we could extract, but also that the nature of the interventions implemented or the characteristics of the measures used were sometimes only superficially addressed. With each missing or imprecise data point, our likelihood of deriving reliable and valid conclusions was diminished.

Despite these risks, calculated and otherwise, we feel that we have, in fact, learned much from this review that will contribute to our programs of research in the future. We trust that our insights and implications will prove beneficial to others, as well. At a minimum, we hope that this review will serve as a catalyst that prompts or cues those who engage in research in metacognition, self-regulation, or self-regulated learning to *monitor* their choice of terminology, to *control* the manner in which their constructs are conceptually and operationally defined, and to *regulate* the way in which their intentions and understandings are communicated to others.

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