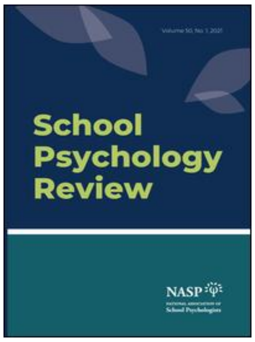

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Characteristics and Uses of SRL Microanalysis across Diverse Contexts, Tasks, and Populations: A Systematic Review

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ABSTRACT

The primary purpose of this study was to systematically review the literature regarding the characteristics, use, and implementation of an emerging assessment methodology, *SRL microanalysis*. Forty-two studies across diverse samples, contexts, and research methodologies met inclusion criteria. The majority of studies used microanalysis to either comprehensively address all three phases of SRL (i.e., forethought, performance, or reflection) or to conduct in-depth analyses of one particular phase. Microanalysis has also been used across myriad domains (e.g., academic, athletic, clinical) and tasks (e.g., mathematics problem solving, basketball shooting, diagnostic reasoning) with samples encompassing elementary to graduate school. Although SRL microanalysis has typically been used to differentiate intervention conditions or existing groups (e.g., expert vs. novice), it has increasingly been used as a diagnostic tool to inform instructional and intervention planning. Additional information regarding the types of validity addressed in the studies are discussed, as well as implications for research and school practice.

IMPACT STATEMENT

This study critically evaluates the literature regarding a contextualized assessment approach called self-regulated learning (SRL) microanalysis. Microanalysis approaches can be used to assess SRL skills in school-aged populations across myriad domains, tasks, and populations and shows promise as both a research and formative assessment tool guiding intervention planning.

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School psychologists are often called upon to conduct multidimensional psychoeducational evaluations as part of a refer-test-place service delivery model. These evaluations often involve gathering data from multiple methods (e.g., standardized tests, direct observations, interviews) and sources (e.g., students, parents, teachers) to generate hypotheses about student functioning across cognitive, academic and/or social–emotional domains (Alfonso & Flanagan, 2018). Although this more traditional assessment approach remains relevant to school-based practice, there has been increased interest in alternative service delivery models (e.g., multi-tiered systems of support [MTSS]) that emphasize contextualized and more narrow forms of assessment, such as the curriculum-based measurement (Jimerson et al., 2016). A key advantage of these specific forms of assessment is the generation of data that can be used to guide school team decisions regarding the selection, implementation, and evaluation of interventions at varying levels of intensity (multiple tiers; Batsche et al., 2005; National Center on Response to Intervention [NCRI], 2010).

A focus on task-specific and more contextualized forms of assessment has also been emphasized in other fields or lines of research, such as self-regulated learning (SRL). That is, SRL researchers have become increasingly interested in evaluating students' regulatory skills as they engage in specific learning or performance activities, and then striving to link such assessments to the development and/or evaluation of SRL interventions (Cleary et al., 2017; Peters-Burton & Botov, 2017; Schunk & Greene, 2018). SRL researchers often discuss two broad assessment categories (i.e., aptitude measures and event measures) that can be distinguished in terms of format, procedures, and overall scope and purpose (Cleary & Callan, 2018; Winne & Perry, 2000).

Aptitude SRL measures, which include self-report questionnaires, rating scales, and certain types of interviews, represent a collection of approaches that gather data about SRL as a global attribute or enduring trait of a person.

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These measures rely on individuals' retrospective ratings and typically provide broad-based, aggregate scores from multiple items or questions; thus, they do not capture SRL processes as they occur at a specific time point within a given situation or setting. Event measures, on the other hand, are designed to gather data about SRL processes as they emerge or change in specific moments, situations, or learning activities (Schunk & Greene, 2018). Examples of event measures include behavioral traces, think alouds, and SRL microanalysis. In short, whereas aptitude measures address the question of how students typically or "on average" exhibit adaptive regulatory actions or beliefs within a general domain, event measures generate data to convey how individuals initiate, monitor, and adapt their strategic thinking and actions during a *specific activity* in a *given situation* at a particular *moment in time* (Bernacki, 2018; Cleary & Callan, 2018; Greene et al., 2018).

Several event measures (e.g., think aloud protocols, behavioral traces) have been widely used and evaluated for several decades, but other event approaches, such as SRL microanalysis, have received increased attention and interest (Cleary & Callan, 2018). Although originally developed to study SRL processes within athletic or sports contexts, SRL microanalysis has increasingly been used to examine student SRL across school-related areas and activities, such as test preparation, writing, reading, and mathematics. Given the viability of using microanalysis to assess SRL across important academic activities and given its general alignment with school-based initiatives (e.g., situational and contextualized assessments), the current study addresses a timely and important gap in the school psychology literature. Specifically, we examine trends in the use of SRL microanalysis use across different domains and activities, as well as the types of evidence to support the validity of inferences drawn from microanalysis scores.

Overview of Self-Regulation

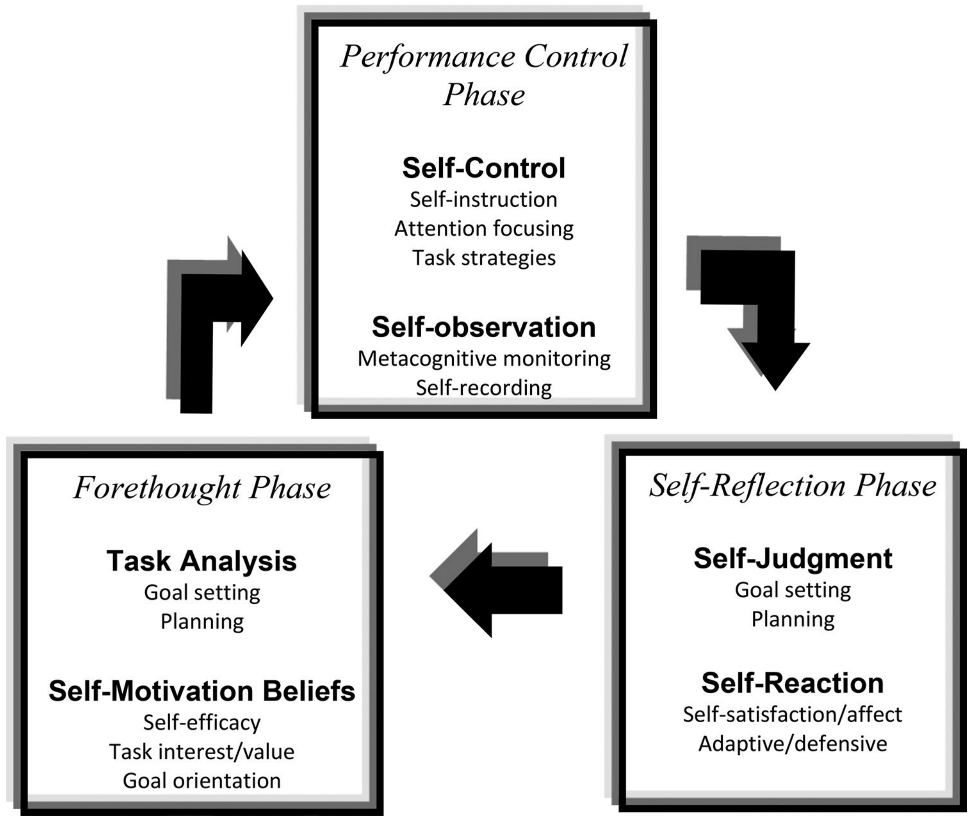
Self-regulation is widely recognized as a core 21st century learning skill for academic success, as well as an essential component of adaptive social–emotional functioning, well-being, and physical health (Cleary, 2015; Schunk & Greene, 2018; Vohs & Baumeister, 2016). Although most researchers would also agree with the general premise that human regulation involves the process through which people manage, control, and adapt their behaviors to attain desired goals, there are distinct terms, definitions, and theoretical frameworks (Schunk & Greene, 2018; Vohs & Baumeister, 2016). In fact, researchers have increasingly distinguished between terms like *self-regulation* (SR) or *self-control* (i.e., an individual's ability to resist temptations and control behavior, typically in nonacademic domains) and *self-regulated learning* (SRL; i.e., self-regulation process during learning or academic activities in school contexts).

SR research tends to be conducted by developmental, social, and cognitive psychologists and typically focuses on regulation for nonacademic tasks, such as weight management, substance use, and behavioral functioning. One classic model of SR focuses on *executive functions* (EFs) as key cognitive processes underlying the higher-order process of regulation (Barkley, 2004; Blair, 2016). This model is often used to describe students with behavioral and/or learning disabilities. Another common model of SR espouses the premise that self-regulation is a limited, finite resource that becomes weakened or diminished following attempts to control behavior (Muraven et al., 2002). This strength or limited resource model suggests that using one's self-control resources to manage behavior in one situation will decrease the amount of resources one can leverage when attempting to engage in effortful control during future tasks.

SRL and SR models are most notably distinguished in that SRL models tend to emphasize the situational and contextualized dimensions of regulation rather than broad cognitive abilities or overall capacity. In fact, most SRL models discuss regulation in terms of an integration *cyclical feedback loop*, a process or mechanism through which individuals set goals and plans, use strategies to learn, and gather information and feedback to evaluate goal progress and make adaptations as needed. Microanalysis approaches are specifically grounded in Zimmerman's (2000) three-phase, cyclical model. From this perspective, SRL is a process including three interdependent, sequential phases: forethought, performance control, and self-reflection (see Figure 1). Forethought phase processes include *task analysis processes*, such as goal-setting and strategic planning, and *motivational beliefs*, such as self-efficacy and task interest. Collectively, forethought processes are hypothesized to occur before one engages in a learning activity and, thus, set the stage or foundation for regulatory actions (Zimmerman, 2000). That is, when students have a clearly defined goal for a specific learning activity and develop an effective plan for goal attainment, they are more likely to strategically approach learning activities (Callan & Cleary, 2018, 2019). Motivational beliefs are also emphasized in this model in that they can influence student actions and efforts to engage in regulatory activities (Cleary & Kitsantas, 2017; Urdan & Pajares, 2006). Although these motivational beliefs are conceptualized as a forethought process, they have been shown to predict multiple SRL processes in all phases.

As learners engage in a specific activity, they utilize different performance phase sub-processes: *self-control*

Figure 1. Phases and Processes of Self-Regulation



Note. From "Motivating self-regulated problem solvers" by B. J. Zimmerman & M. Campillo (2003). In J. E. Davidson & R. J. Sternberg (Eds.), *The Psychology of Problem Solving* (p. 239). New York: Cambridge University Press. Reprinted with permission.

and *self-observation* (see Figure 1). Self-control processes, which include learning strategies (e.g., summarization, concept maps) and regulatory strategies (e.g., time management, attention control, and self-instruction), are designed to help students optimize their focus, effort, and learning or acquisition of information. *Self-observation*, which involves tracking or monitoring thoughts and actions (i.e., to mentally track), performance, as well as the conditions or contextual factors surrounding performance, is another critical component of the performance phase because it helps students generate information that can be used to reflect on and evaluate performance.

After attempting to learn and/or receive performance feedback, regulated learners engage in self-reflection. Zimmerman embeds two broad processes within the self-reflection phase: *self-judgments* and *self-reactions*. When making judgments about performance, individuals will typically evaluate the quality of performance and/or attainment of goals (i.e., self-evaluation) and seek to identify the reasons for their performance (i.e., attributions). These reflective judgments (i.e., "how well did I do" and "why did I perform this way") play a critical role in determining how students feel about their learning (i.e., *satisfaction/affect*), as well as their perceptions regarding how to adapt or change prior to future task engagement (i.e., *adaptive inferences*). A cyclical loop is considered complete when reflective judgments influence individuals' forethought as they engage in subsequent learning attempts.

SRL Assessment Practices: SRL Microanalysis

There has been much growth over the past couple of decades in the range of approaches researchers and practitioners have used to measure SRL, including interviews, self-report questionnaires, think alouds, behavioral traces, and diary logs (Cleary, 2011; Roth et al., 2016; Schunk & Greene, 2018; Wolters & Won, 2017; Zimmerman, 2008). As noted previously, aptitude measures (e.g., self-report questionnaires) depict SRL as an enduring trait, whereas event measures generate data that represents SRL as a dynamic and context-specific process (Azevedo et al., 2010). Although both categories of assessment are important and useful for understanding SRL functioning, researchers have increasingly utilized event measures to evaluate SRL in a more task-specific and moment-to-moment manner (Bernacki, 2018; Greene et al., 2018).

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SRL microanalysis, which is the focal point of the current review, is unique in format and structure relative to event measures. It entails a task-specific structured interview to assess cyclical SRL processes (e.g., goal-setting, self-observation, attributions) as individuals engage in learning or performance-related activities. Although the specific characteristics of SRL microanalysis are described elsewhere (Cleary, 2011; Cleary et al., 2012), we briefly summarize this approach in terms of the steps one can take to construct SRL microanalysis assessments. We provide an example SRL microanalysis interview as a supplemental resource (see Supplemental Material Sample S1, Sample Microanalysis Protocol).

The initial step, which is perhaps the most critical, is to first identify the task or activity around which one seeks to assess SRL. Given that human regulation and motivation often vary across contexts and specific activities or situations (Hadwin et al., 2001; Schunk & Greene, 2018), SRL microanalysis assessments are intricately linked and embedded within these activities. Thus, developing an effective microanalysis approach requires one to identify and understand the target activity, including its inherent demands, challenges, and temporal dimensions (i.e., beginning, middle, and end). One must also identify and select the SRL processes to directly assess. Although it is appropriate and advantageous to comprehensively examine SRL processes across all three cyclical phases, there may be instances or situations when it is relevant or feasible to target a specific SRL phase, such as forethought or reflection. For example, Cleary et al. (2015) specifically targeted students' reflection phase processes given that the target activity (i.e., reflection on exam grades) was not applicable to forethought or performance phases.

Following selection of the target task and SRL processes, researchers can use existing microanalysis questions or to develop new questions customized to the target activity. Microanalysis questions should be simple, brief, and directly linked to a specific regulatory process, typically as delineated in Zimmerman's three-phase model (Cleary, 2011). Questions are worded to reflect the definitions of SRL subprocesses in relation to the target activity. Thus, to assess students' goal-setting and attributions relative to writing an essay in English class, example questions might include, "*Do you have a goal in mind as you prepare to write this essay?*" (goal-setting) and "*What is the main reason why you got that grade on the essay?*" (attributions). Free response or open-ended formats are often emphasized in microanalysis assessments because they generate information regarding regulatory functioning at a particular moment in time without prompts about specific processes, as is the case with self-report questionnaires. However, metric or quantitative questions (e.g., Likert scale) are often utilized when assessing certain types of processes, such as motivational beliefs (e.g., self-efficacy, task interest, value, satisfaction).

A culminating step in constructing a microanalysis approach is planning the sequence of questions. For any given target activity, one must clearly demarcate its temporal dimensions (i.e., before, during, and after the activity). Ultimately, microanalysis assessments are constructed so that phase-specific questions (i.e., forethought, performance, self-reflection) are aligned with the before, during, and after dimensions of the target activity. Thus, forethought questions (e.g., goal-setting, planning) are administered prior to an individual engaging in the target activity, performance questions (e.g., self-observation, monitoring) during the activity, and reflection questions following the activity or after receiving some type of performance feedback. The basic logic is that by merging task temporal dimensions with the cyclical feedback loop, more appropriate and meaningful inferences can be made regarding the nature of SRL processes as students engage in specific tasks (Cleary & Callan, 2018). Given that school psychologists and teachers interact directly with students and are often interested in helping students improve their motivational and regulatory skills for specific situations and activities, SRL microanalysis has much potential for use in school-based settings (Cleary et al., 2010; Spruce & Bol, 2015).

Two important caveats about SRL microanalysis are important to note. First, the term *microanalysis* has been used by researchers across diverse fields, such as human development, psychology, counseling, education, medicine and sports. Similar to SRL microanalysis, other forms of microanalysis also target fine-grained specific behaviors or processes as they emerge during specific situations or events. In developmental and counseling research, researchers have microanalytically examined behavioral interpersonal relations or interactions among individuals, such as mother–infant interactions (e.g., Beebe et al., 2010; Valentovich, 2019), complex family interactions (e.g., Gordon & Feldman, 2008), and therapist–client exchanges (e.g., Guzman et al., 2014). SRL researchers have also used the stem "micro" to denote the specific activities or subprocesses within the more macro level SRL processes such as monitoring and planning (Greene & Acevedo, 2009). Most researchers who use the term SRL microanalysis, however, refer specifically to a set of task-specific questions targeting well-defined SRL processes that are administered to match the temporal dimension of a given learning activity.

Second, the conceptual foundation of SRL microanalysis has its roots in formative assessment, as well as the emergence of social–cognitive theory and cognitive–behavioral therapy in the 1970s (Cleary, 2011). Collectively, these influences emphasized the relevance of iteratively assessing human cognition and actions or behavior (i.e., sources of evidence) to generate scores that can be used to enhance understanding of human behavior and inform plans to improve functioning. Bandura introduced the term *microanalysis* in the 1970s to represent his use of self-efficacy measures to assess shifts in adults' confidence to interact with a feared stimulus (e.g., snakes) and to illustrate how these shifts corresponded to behavioral performance during anxiety-reduction interventions (Bandura et al., 1982; Bandura & Adams, 1977). This contextualized and nuanced measurement of motivation beliefs was expanded by Zimmerman and colleagues in the late 1990s and early 2000s to target both motivational beliefs and regulatory processes within the three-phase cyclical feedback loop (i.e., forethought, performance, self-reflection; Cleary & Zimmerman, 2001; Kitsantas et al., 2000; Zimmerman & Kitsantas, 1997). Broadly speaking, this systematic review targets the latter group of studies beginning in the late 1990s.

Rationale and Purpose of Study

As professionals in many fields continue to recognize the importance of situation-dependent and task-specific forms of assessment, questions arise regarding the applicability and validity of such approaches. In the case of SRL microanalysis, there is clearly a strong theoretical foundation and an emerging empirical basis for its use across diverse domains, activities, and populations (e.g., Artino et al., 2014; Follmer & Sperling, 2019; Kitsantas & Zimmerman, 2002; McPherson et al., 2019). Although several book chapters and articles (e.g., Cleary, 2011; Cleary et al., 2012; Cleary & Callan, 2018) have been published that address the key features and characteristics of SRL microanalysis, to our knowledge there has been no attempt to critically and systematically examine the SRL microanalysis literature, and to investigate the use and application of SRL microanalysis across different *domains* (e.g., academics, clinical, athletic), *areas* within a domain (e.g., reading and mathematics within academic domains; basketball and volleyball within athletic domain), *activities* (e.g., shooting free throws, solving mathematics problems) and *student populations* (e.g., grade levels). There is also a need to examine the range of SRL processes included in microanalysis studies or the types of validity evidence supporting the validity inferences drawn from SRL microanalysis scores. Given that SRL microanalysis can be used for multiple purposes (i.e., diagnostic, evaluation, or intervention tool), there is a need to gather data that support these uses.

With these gaps in mind, the current systematic review addressed three primary research questions: (a) To what extent have microanalysis studies targeted a diverse range processes within and across the cyclical feedback model of SRL?; (b) What are key trends in SRL microanalysis regarding its purposes and uses across different domains, activities, and populations?, and (c) What types of evidence have been gathered to support the validity of inferences drawn from microanalysis scores? With regard to validity, we used the *Standards for Educational and Psychological Testing* (AERA et al., 2014) as a guiding framework and evaluated all studies to determine if they provided evidence to support inferences regarding the convergent/divergent, concurrent/predictive, and consequential validity of microanalysis scores. In addressing these three questions, we seek to provide a conceptual and empirical foundation from which researchers or school practitioners can apply and use microanalysis in their professional activities. Further, given that there are very few, if any, assessment approaches that capture well-defined SRL processes as students learn or engage in academic activities or performance situations, we believe that data generated from this study can be of value and importance to school-based practitioners.

METHOD

Literature Search Approach

Rigorous, comprehensive methods were used to review the SRL microanalysis assessment literature. An illustrative summary of the review process and article count is provided as supplemental material (see Supplemental Material Figure S2. PRISMA flowchart: An illustrative summary of the review process).

Broadly speaking, our approach ensured that peer-reviewed journal articles and dissertations from 1997 to 2020 were identified across a wide range of domains including education, school psychology, sports, music, and teaching and learning literatures. The review target studies from 1997 and beyond given that to our knowledge this initial components of this methodology were first introduced by Zimmerman and Kitsantas (1997; see also Cleary et al., 2012). A series of steps were followed to conduct the review. First, we conducted a comprehensive computerized bibliographic search using the key terms "microanalysis" AND "self-regulated learning", "self-regulation", "forethought", "performance", "self-reflection", "goal", "plan", "strategy", "self-monitoring", "self-evaluation", "self-judgment", "attribution", "affect", "adaptive", "assess", "measure", OR "protocol". Several research databases were used (i.e., Web of Science, PsycInfo, EBSCOhost [i.e., Academic Search Premier, Business Source Premier, and The Cumulative Index to Nursing and Allied Health Literature (CINAHL)], ProQuest Social Sciences Premium

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Collection, Google Scholar, PubMed, Education Resource Information Center [ERIC], PsycArticles, Sociological Abstracts, and Wiley Online Library). Variations of the key terms were used to increase the likelihood of identifying relevant studies (e.g., microanalytic, self-regulate, self-reflective, goal setting, planning, attribute, measurement).

Second, we used the search functions for 14 peer-reviewed journals that have recently published SRL studies (i.e., *Journal of Educational Psychology, Education Research International, International Journal of Educational and Psychological Assessment, Psychology in the Schools, School Psychology Quarterly, Psychology of Music, International Journal of Sports Psychology, International Review of Sport and Exercise Psychology, Psychology of Sport and Exercise, Journal of Sport and Exercise Psychology, Journal of Applied Sports Psychology, Research Quarterly for Exercise & Sport, Metacognition and Learning*, and *Journal of School Psychology*) to further identify studies that may have been missed in the first step. Collectively, these first two steps resulted in a pool of 4,055 unique peer-reviewed articles and/or dissertations.

In step three, we carefully reviewed the abstracts of studies from the initial search (4,055 studies) and systematically screened them using several inclusion and exclusion criteria: (a) written in English; (b) included specific SRL subprocess (e.g., forethought, planning, goal-setting) or the words "microanalysis" and "self-regulated learning" (or a variation of these words); and (c) included quantitative or qualitative analyses of original data. Conceptual papers or reviews of microanalysis procedures were excluded from this review. At the beginning of this stage, articles and dissertations that very clearly did not meet the inclusion criteria were ruled out. If an abstract did not provide sufficient information (e.g., it was not clear if article was a review or an analysis of original data) to determine eligibility, the study was retained, and inclusion was not ruled out. To ensure the accuracy of the coding process, two authors independently reviewed an initial set of approximately 300 abstracts (i.e., after removal of clear rule outs) to determine if the abstracts met inclusion criteria. The coders then met to compare their decisions and reach consensus. Two other authors with substantial experience in the coding process provided support during this consensus process. The abstract review resulted in a total of 54 studies. To ensure that the most recently published articles were included in our review, we contacted several authors of previously published microanalysis studies and conducted an updated search for studies published through September 2020 (original search was conducted in March 2020). These final steps led to identifying an additional 6 studies ($n = 60$) using the review process described above.

All of the identified studies were then subject to a "full review" which involved using the prior criteria as well as two additional inclusion criteria. All studies had to include at least one regulatory process in the forethought, performance, or reflection phases. Further, the administration of microanalysis questions needed to be linked with the temporal dimensions of the target activities (e.g., forethought phase questions needed to be administered before the participant began the target activity). When using these criteria, 18 articles were removed, leaving the final sample of 42 peer-reviewed articles and dissertations. A summary of inclusion criteria is provided as supplemental material (see Supplemental Material Table S3, Summary of Inclusion Criteria).

Structured Review Coding System

A modified structured review coding system based on previously published reviews and meta-analyses (Reddy et al., 2009, 2018) was created to systematically review the 42 studies. This coding system included 13 variables within two broad categories: (a) SRL microanalysis assessment features, and (b) overall design and methodology. Regarding the SRL microanalysis assessment, six variables were coded: (a) purpose of assessment (e.g., differentiate treatment groups, use as an instructional or intervention tool); (b) domain (e.g., academics, athletics, clinical); (c) domain area (e.g., testing, mathematics, basketball); (d) task or activity (e.g., test preparation, problem-solving, shooting a ball); (e) phase of SRL (i.e., forethought, performance, self-reflection); and (f) specific SRL subprocesses within each phase (e.g., strategic planning, goal-setting, self-observation, attributions) and motivation beliefs (i.e., self-efficacy, interest, instrumentality/value). As noted in the introduction, we conceptualized motivation as distinct from the three phases as defined by Zimmerman (2000).

We also coded seven variables representing sample characteristics and research design. Sample characteristics had five variables (i.e., sample size, age, grade, gender, and ethnicity), and research design had two variables (i.e., purpose of microanalysis assessment, type of validity).

All studies were screened and independently coded by two trained raters using the structured review coding system. Coders were trained by the first author, who also served to resolve disagreements or other matters related to the coding process. There were two rounds of article review: one research assistant conducted an initial round of coding and another research assistant reviewed the coding to highlight any disagreements. The first and/or second authors reviewed all completed coding forms and discussed disagreements with the coders. Final agreement was established based on group consensus between these individuals. Given the process of consensus-building across all codes, intercoder reliability was not calculated.

RESULTS

Detailed descriptive information for each of the 42 studies are provided in Table 1. Overall, the sample sizes across studies ranged from 2 to 191 participants. More than half of the studies ($n = 22$) included sample sizes over 50 participants. Studies also varied in their targeted population: elementary school students ($n = 5$; 12%), middle school students ($n = 6$; 14%), high school students ($n = 12$; 29%), college students ($n = 10$; 24%) medical students and residents ($n = 6$; 14%), and K–12 teachers ($n = 3$; 7%). Finally, six of the 42 studies were conducted outside of the United States.

Descriptive analysis of information drawn from Table 1 was used to address the three research questions of the current study. Additional tables are presented to summarize the key findings related to the core objectives of the study.

Nature of SRL Processes Targeted by Microanalysis Assessments

Our first question addressed the extent to which microanalysis assessments have addressed the breadth of SRL processes targeted within and among the three-phases. At the broad *phase* level, we investigated the extent to which studies focused on one, two, or all three phases (see Table 2). We observed that the majority of studies targeted SRL processes across all phases (i.e., forethought, performance, and self-reflection; $n = 21$; 50%). Interestingly, approximately one third of the studies ($n = 14$; 33.33%) focused on only one phase, with almost all of these studies ($n = 13$; 92.86%) addressing self-reflection phase processes (e.g., self-evaluation, attributions). Seven (16.67%) studies included two SRL phases; all of them included forethought as one of the phases but none addressed both the performance and reflection phases.

At this phase level of analysis, we also found that reflection processes were most frequently emphasized (see Table 3). Although approximately two thirds of the studies targeted at least one forethought ($n = 28$; 66.67%) or performance control phase process ($n = 26$; 61.90%), over 90% of the studies targeted at least one self-reflection process ($n = 38$).

When conducting more fine-grained descriptive analysis of the frequency of SRL processes targeted *within* each phase, a couple of notable patterns emerged (see Table 3). For the performance phase, studies were almost evenly split in their focus on strategy use (45.24%) and self-observation or monitoring (52.38%). In contrast, there was greater variability among reflection phase processes. Attributions ($n = 32$; 76.19%) and satisfaction/affect ($n = 24$; 57.14%) represented the most common processes included in the assessments, while self-evaluative standards ($n = 6$; 14.29%) was targeted much less frequently.

Microanalysis Uses and Applications

Our second research question involved examining the various ways in which microanalysis assessments have been used by researchers. Two general application dimensions were considered in addressing this issue: (a) overall purpose or function of microanalysis in a given study, and (b) use across domains, domain areas, tasks, and populations. In terms of purpose, it is important to note that some studies used microanalysis for more than one purpose. Most researchers used microanalysis to distinguish different types of groups; that is, treatment groups ($n = 15$; 35.71%) or naturally existing groups, such as experts and novices ($n = 13$; 30.95%; see Table 4). However, approximately one third of the studies used microanalysis to closely examine—quantitatively or qualitatively—the nature or patterns of SRL skills within a single group or for specific cases ($n = 13$; 30.95%). Finally, approximately 19% of the studies used microanalysis as a diagnostic or instructional tool. Interestingly, researchers have shown increased use of microanalysis for formative assessment or instructional purposes. In fact, of the ten microanalysis studies published since 2018, four (40%) have used microanalysis as a diagnostic tool to enhance instructional or intervention efforts.

SRL microanalysis application was also considered in terms of its use across domains, activities, and populations. Approximately half of the studies in this review focused on academic-related domains areas, such as writing, mathematics, reading, science, and history ($n = 20$; 47.62%; see Table 5). Of comparable importance was the broad range of academic activities and tasks to which microanalysis assessments have been applied. The most common tasks addressed in the academic realm included test-related activities (i.e., test preparation, test taking, test reflection), mathematics problem-solving, and writing.

Besides academics, the next most common domain targeted by microanalysis assessments included athletics ($n = 10$; 23.81%) and clinical activities ($n = 6$; 14.29%; see Table 5). The sports-related studies assessed SRL during activities, such as throwing darts, shooting a basketball, serving a volleyball, and kicking soccer balls. In the clinical realm, diagnostic reasoning activities in a medical context

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Table 1. SRL Microanalysis Assessment and Research Design Characteristics Across Studies ($n = 42$)

Study	Sample Characteristics	Domain (Area) – Type of Task	Targeted SRL Phase and Processes	Use of Microanalysis Assessment	Types of Validity
Zimmerman and Kitsantas (1997)	$n = 90$ 9th–10th graders All female	Athletics (darts)– dart throwing	Reflection: Attribution, satisfaction/affect Motivation beliefs: Self-efficacy, interest	Intervention groups	Convergent Concurrent
Kitsantas and Zimmerman (1998)	$n = 90$ 9th–10th graders All female	Athletics (darts)–dart throwing	Reflection: Attribution, satisfaction/affect Motivation beliefs: Self-efficacy, interest	Intervention groups	Convergent Concurrent
Zimmerman and Kitsantas (1999)	$n = 84$ 9th–11th graders All female	Academic (writing)–sentence combining	Reflection: Attribution, satisfaction/affect Motivation beliefs: self-efficacy, interest	Intervention groups	Convergent Concurrent
Kitsantas et al. (2000)	$n = 60$ 9th graders All female	Athletics (darts)–dart throwing	Reflection: Attribution, satisfaction/affect Motivation beliefs: Self-efficacy, interest	Intervention groups	Convergent Concurrent
Cleary and Zimmerman (2001)	$n = 43$ High school students All male experts, nonexperts, & novices	Athletics (basketball)–free throw shooting	Forethought: Strategic planning (strategy choice), goal-setting Reflection: Attribution, satisfaction/affect Motivation beliefs: Self-efficacy	Natural groups	Convergent Concurrent
Kitsantas and Zimmerman (2002)	$n = 30$ College students All female Experts, nonexperts, & novices	Athletics (volleyball)–serving	Forethought: Strategic planning, goal-setting Performance: Strategy use, self-observation (monitoring) Reflection: Self-evaluation, attribution, adaptive inferences, satisfaction/affect Motivation beliefs: Self-efficacy, interest, instrumentality	Natural groups	Concurrent
Silva (2003)[a]	$n = 52$ Middle school students Experts, nonexperts, physically awkward Canada	Athletics (soccer)–kicking	Forethought: Strategic planning (strategychoice), goal-setting Reflection: Attribution, satisfaction/affect Motivation beliefs: Self-efficacy	Natural groups	Concurrent
Cleary et al. (2006)	$n = 50$ College students Novice basketball players	Athletics (basketball)–free throw shooting	Reflection: Self-evaluative standard, attribution, adaptive inferences	Intervention groups	Convergent Concurrent
Kitsantas and Zimmerman (2007)	$n = 70$ College students Novice dart throwers	Athletics (darts)–dart throwing	Reflection: Self-evaluation, attribution, satisfaction/affect Motivation beliefs: Self-efficacy	Intervention groups	Convergent Concurrent
Cleary et al. (2008)	$n = 7$ 9th graders Honors biology	Academic (science)–test reflection	Reflection: Attribution, adaptive inferences	Single group/case & diagnostic/ instructional/ intervention tool	Consequential

(Continued)

Table 1. Continued

DiBenedetto and Zimmerman (2010)	$n = 51$ 11th graders High, average, & low achieving	Academic (science)–reading and studying	Forethought: Strategic planning, goal-setting Performance: Strategy use, self-observation (metacognitive monitoring) Reflection: Attribution, adaptive inferences, satisfaction/affect Motivation beliefs: Self-efficacy, interest	Natural groups	Convergent Concurrent
Labuhn et al. (2010)	$n = 90$ 5th graders Germany	Academic (mathematics)–problem-solving	Reflection: Self-evaluation, self-evaluative standards (self-judgment), satisfaction/ affect Motivation beliefs: Self-efficacy	Intervention groups	Convergent Concurrent
Platten (2010)[a]	$n = 65$ 6th–8th graders	Academic (reading)–vocabulary	Forethought: Goal-setting Performance: Strategy use (choice) rationale Reflection: Attribution, adaptive inferences, self-evaluative standards, satisfaction/affect Motivation beliefs: Self-efficacy, interest, instrumentality/value	Intervention groups	Concurrent Convergent
Cleary and Sandars (2011)	$n = 7$ 3rd year medical students United Kingdom	Clinical (medical)–venipuncture	Forethought: Goal-setting, strategic planning Performance: Self-observation (metacognitive monitoring) Reflection: Self-evaluative standards, satisfaction/affect Motivation beliefs: Self-efficacy	Natural groups	Concurrent
Kolovelonis et al. (2011)	$n = 105$ 5th–6th graders Novice dart throwers Greece	Athletics (darts)–dart throwing	Reflection: Attribution, adaptive inferences, satisfaction/affect Motivation beliefs: Self-efficacy, interest (enjoyment)	Intervention groups	Concurrent Convergent
Winkler (2011)[a]	$n = 40$ 1st year college students Expert, nonexpert, & novice	Academic (Google search)–website search/analysis	Forethought: Strategic planning, goal-setting Performance: Self-observation Reflection: Self-evaluation, attribution Motivation beliefs: Self-efficacy, interest, instrumentality/value	Intervention groups	Concurrent Convergent
Cleary and Platten (2013)	$n = 4$ 9th graders Honors biology	Academic (science)–test reflection	Reflection: Attribution, adaptive inferences	Single group/case & diagnostic/instructional/intervention tool	Consequential
DiBenedetto and Zimmerman (2013)	$n = 51$ 11th graders High, average, & low achieving	Academic (science)–reading and studying	Forethought: Strategic planning Performance: Strategy use Reflection: Self-evaluation (metacognitive monitoring)	Natural groups	Convergent Concurrent

(*Continued*)

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Table 1. Continued

Mandell (2013)[a]	$n = 30$ 7th graders High, average, & low achieving	Academic (science)–learning in hypermedia	Forethought: Strategic planning, goal-setting Performance: Strategy use, self-observation Reflection: Self-evaluation, attribution, adaptive inferences, satisfaction/affect Motivation beliefs: Self-efficacy, Interest	Natural groups	Convergent Concurrent
Artino et al. (2014)	$n = 71$ 2nd year medical students	Clinical (medical)–diagnostic reasoning task	Forethought: Strategic planning, goal-setting Performance: Self-observation	Single group/case	Convergent Predictive
Nelson (2014)[a]	$n = 15$ High school students AP & regular classes	Academic (history)–text reading in preparation for quiz	Forethought: Strategic planning, goal-setting Performance: Strategy use, self-observation (monitoring) Reflection: Self-evaluation (grade estimate), attribution, adaptive inferences, satisfaction/affect Motivation beliefs: Self-efficacy, interest, instrumentality/value	Natural groups	Convergent Concurrent
Cleary et al. (2015)	$n = 49$ College students in educational psychology course	Academic (psychology)–course exams	Forethought: Strategic planning Reflection: Self-evaluation, attribution, adaptive inferences, satisfaction/affect Motivation beliefs: Self-efficacy	Single group/case	Convergent Concurrent Predictive
Cleary et al. (2015)	$n = 71$ 2nd year medical students	Clinical (medical)–diagnostic reasoning task	Forethought: Strategic planning Performance: Self-observation (metacognitive monitoring) Motivation beliefs: Self-efficacy	Single group/case	None
Griswold (2015)[a]	$n = 34$ High school students Marine science & zoology courses	Academic (science)–writing task	Forethought: Strategic planning, goal-setting Performance: Strategy use (choice), self-observation Reflection: Self-evaluation, attribution, adaptive inference (feedback loop), satisfaction/affect (apprehension) Motivation beliefs: Self-efficacy	Single group/case	None
Huie (2015)[a]	$n = 191$ College students in non-introductory math course	Academic (mathematics)–test taking in stereotype threat	Forethought: Strategic planning, goal-setting Performance: Strategy use, self-observation (metacognitive monitoring) Reflection: Self-evaluative standards, attribution, satisfaction/affect Motivation beliefs: Self-efficacy, instrumentality/value	Single group/ case	Concurrent Convergent
Lau et al. (2015)	$n = 9$ 3th–5th graders High, average, & low achieving	Academic (mathematics)–completing math problem	Forethought: Strategic planning Performance: Strategy use, Self-observation Reflection: Self-evaluation, attribution, adaptive inferences, satisfaction/affect Motivation beliefs: Self-efficacy, interest, goal orientation	Natural groups	Concurrent

(*Continued*)

Table 1. Continued

Gandomkar et al. (2016)	*n* = 76 1st year medical students High & low achieving Iran	Clinical (science)–biomedical science task	Forethought: Strategic planning, goal-setting Performance: Self-observation (metacognitive monitoring) Reflection: Attribution, adaptive inferences Motivation beliefs: Self-efficacy	Natural groups	Concurrent
Hogan (2016) [a]	*n* = 46 Adults	Training (webinar)–online PD task	Forethought: Strategic planning, goal-setting, task definition Performance: Self-observation (enactment-metacognitive), strategy use (enactment-cognition) Reflection: Self-evaluation, self-evaluative standards (adaptations)	Intervention groups	Convergent
Cleary et al. (2017)	*n* = 42 7th graders	Academic (mathematics)–test reflection	Reflection: Attributions, adaptive inferences	Intervention groups & diagnostic/ instructional/ intervention tool	Convergent Predictive Convergent
McPherson et al. (2019)	*n* = 2 1st year college students High & low audition scores	Music (piano)–practice	Forethought: Strategic planning, goal-setting Performance: Strategy use, self-observation (metacognitive monitoring and self-recording) Reflection: Self-evaluation, attribution, adaptive inferences satisfaction/affect Motivation beliefs: Self-efficacy, interest, goal orientation	Natural groups	None
McCarthy-Gonzalez (2017)[a]	*n* = 60 9th–11th graders Algebra II course	Academic (mathematics)–completing math problems	Forethought: Strategic planning, goal-setting Performance: Strategy use Motivation beliefs: Self-efficacy	Intervention groups	Convergent Concurrent
Peters-Burton and Botov (2017)	*n* = 14 Elementary earth science teachers	Training (PD)–lesson plan development	Forethought: Goal-setting Performance: Strategy use, self-observation (self-monitoring) Reflection: Self-evaluation, attribution, satisfaction/affect Motivation beliefs: Self-efficacy, interest, instrumentality/ value	Single group/case & diagnostic/ instructional/ intervention tool	Consequential
Andrews et al. (2018)	*n* = 20 Medical residents	Clinical (medical)–vignette-based test question	Reflection: Self-evaluation, attribution, adaptive inferences Motivation beliefs: Self-efficacy	Diagnostic/ instructional/ intervention tool	Consequential
Callan and Cleary (2018)	*n* = 100 8th graders	Academic (mathematics)–problem solving activity	Performance: Strategy use, self-observation (metacognitive monitoring)	Single group/case	Convergent Predictive Concurrent

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Table 1. Continued

Miksza et al. (2018)	*n* = 3 UG music education course	Music (varied instruments)–practice	<u>Forethought</u>: Strategic planning, goal-setting <u>Performance</u>: Strategy use, self-observation <u>Reflection</u>: Attribution, adaptive inferences, satisfaction/affect <u>Motivation beliefs</u>: Self-efficacy, interest, instrumentality/value, goal orientation	Single group/case & diagnostic/instructional/intervention tool	Consequential
Callan and Cleary (2019)	*n* = 96 8th graders	Academic (mathematics)–completing word problems	<u>Forethought</u>: Strategic planning, goal-setting <u>Performance</u>: Strategy use, self-observation (metacognitive monitoring) <u>Reflection</u>: Self-evaluation, attribution, adaptive inferences	Single group/case	Convergent Concurrent
Callan et al. (2019)	*n* = 58 5th–6th graders	Academic (writing)–creative problem solving	<u>Forethought</u>: Strategic planning <u>Performance</u>: Strategy use <u>Reflection</u>: Self-evaluation <u>Motivation beliefs</u>: Self-efficacy	Single group/case	Convergent Concurrent
Follmer and Sperling (2019)	*n* = 32 UG students in educational psychology course	Academic (psychology)–reading comprehension	<u>Forethought</u>: Strategic planning, task analysis <u>Performance</u>: Strategy use, self-observation <u>Reflection</u>: Attribution	Single group/case	Convergent Concurrent
Kolovelonis et al. (2020)	*n* = 101 5th–6th graders Greece	Athletics (basketball) – shooting/	<u>Forethought</u>: Goal-setting <u>Performance</u>: Self-observation (calibration) <u>Reflection</u>: Attribution	Intervention groups	None
Osborne et al. (2020)	*n* = 33 1st year college students Piano students Australia	Music (piano) – practice	<u>Forethought</u>: Strategic planning, goal-setting <u>Performance</u>: Strategy use, self-observation <u>Reflection</u>: Self-evaluation, attribution, adaptive inferences, satisfaction/affect <u>Motivation beliefs</u>: Self-efficacy, interest, instrumentality/value	Natural groups & diagnostic/instructional/intervention tool	Consequential
Peters-Burton et al. (2020)	*n* = 12 Teachers	Training (PD) – lesson plan development	<u>Forethought</u>: Strategic planning, goal- setting <u>Performance</u>: Self-observation <u>Reflection</u>: Self-evaluation, attribution, satisfaction/affect <u>Motivation beliefs</u>: Self-efficacy, interest, instrumentality/value	Natural groups & diagnostic/instructional/intervention tool	Consequential
Cleary et al. (2020)	*n* = 71 2nd year medical students	Clinical (medical) – diagnostic reasoning	<u>Reflection</u>: Perceived challenges[b], adaptive inferences	Intervention groups	Convergent

Note. All studies occurred in the United States unless otherwise noted in the "sample characteristics" column. In the "targeted SRL phases and processes" column, any process included in parentheses represents the authors' original labels for SRL processes.
[a]Doctoral dissertation. [b]Reflects a type of reflective judgment similar to attributions.

Table 2. Breadth of SRL Phases Targeted by Studies ($n = 42$)

SRL phase	Frequency	Percentage
One phase	14	33.33%
Forethought	0	
Performance	1	
Reflection	13	
Two phases	7	16.67%
Forethought and Performance	3	
Forethought and Reflection	4	
Performance and Reflection	0	
Three phases	21	50.00%

Table 3. SRL Processes Emphasized Across Cyclical Phases

SRL Phase & Processes	# of Studies	Percent of process (in phase)	Overall percent ($n = 42$)
Forethought	28	($n = 28$)	66.67%
Goal-setting	22	78.57%	52.38%
Planning	25	89.29%	59.52%
Task analysis	2	7.14%	4.76%
Performance	26	($n = 26$)	61.90%
Strategy use	19	73.08%	45.24%
Self-observation	22	84.62%	52.38%
Reflection	38	($n = 38$)	90.48%
Self-evaluation	18	47.37%	42.86%
Self-evaluative standards	6	15.79%	14.29%
Attributions	32	84.21%	76.19%
Adaptive inferences	20	52.63%	47.62%
Satisfaction/affect	24	63.16%	57.14%

Note. The percentage column adds to over 100% because studies include more than one SRL process.

Table 4. Primary Purposes of Microanalysis Assessments Across Studies ($n = 42$)

Category	# of Studies	Percentage
Differentiate intervention/treatment groups	15	35.71%
Differentiate naturally-existing groups	13	30.95%
Describe single group/case	13	30.95%
Use as diagnostic, instructional, or intervention tool	8	19.05%

Note. The percentage column adds to over 100% given that studies used microanalysis in more than one way.

Table 5. SRL Microanalysis Assessment Applications Across Domains, Domain Areas, & Tasks ($n = 42$)

Type of Domains, Domain Areas, and Tasks	# of Studies	% of Studies by Context	% of Studies
Academic	*20*		47.62%
Mathematics (problem-solving = 5, test reflection = 1, test taking in stereotype threat = 1)	7	35.00%	16.67%
Science (test reflection = 2, studying = 2, learning in hypermedia = 1, writing task = 1)	6	30.00%	14.29%
Psychology (course exams = 1, reading comprehension = 1)	2	10.00%	4.76%
Writing (sentence combining = 1, creative problem-solving = 1)	2	10.00%	4.76%
Reading (vocabulary)	1	5.00%	2.38%
History (reading for quiz preparation)	1	5.00%	2.38%
Technology (website search and analysis)	1	5.00%	2.38%
Athletics	*10*		23.81%
Darts (throwing at bullseye)	5	50.00%	11.90%
Basketball (shooting the ball)	3	30.00%	7.14%
Volleyball (serving the ball)	1	10.00%	2.38%
Soccer (kicking the ball)	1	10.00%	2.38%
Clinical	*6*		14.29%
Medical (venipuncture =1, diagnostic reasoning =3, vignette-based test question=1)	5	83.33%	11.90%
Science (biomedical science task)	1	16.67%	2.38%
Music	*3*		7.14%
Piano (piano practice)	2	66.67%	4.76%
Varied instruments (instrument practice)	1	33.33%	2.38%
Training	*3*		7.14%
In-person (lesson plan development)	2	66.67%	4.76%
Webinar (online PD task)	1	33.33%	2.38

have been the most common task around which microanalysis questions were developed and implemented. Although the music and training domain categories were less frequently emphasized relative to other domains ($n = 3$; 7.14%), it is noteworthy that each of these two domains represents an emerging area for microanalysis application and interest among researchers.

Validity of Microanalysis Approaches

To address the third research question, we examined whether the 42 studies provided data that supported the validity of inferences drawn from microanalysis scores. In this review, we focused specifically on four types of validity data described within the *Standards for Educational and Psychological Testing* (AERA et al., 2014): convergent validity, concurrent validity, predictive validity, and consequential validity. The majority of the microanalysis studies provided concurrent validity evidence ($n = 28$; 66.7%). These studies focused on the relations between microanalysis scores and some type of achievement or performance indicator at the time microanalysis was administered. Interestingly, very few studies presented information about predictive validity ($n = 4$, 9.5%); that is, the extent to which studies investigated the relationships between microanalysis processes and future skill performance.

Another important finding was that over half of the studies ($n = 26$; 61.9%) reported on evidence of convergent/divergent validity; defined as (a) statistical relations among microanalysis processes, (b) statistical relations between microanalysis processes and other forms of SRL assessment, (c) the extent to which the microanalysis processes distinguished treatment groups in theoretically expected directions. We did not make a distinction between convergent and discriminant validity during the coding process given that studies did not purposefully address discriminant validity in an a priori manner.

Finally, we also found that a growing number of studies provided data that support inferences regarding consequential validity; that is, using microanalysis data to inform instructional or intervention decisions ($n = 7$; 16.7%). Specifically, across academic, medical, and leisure activities, researchers have begun to use microanalysis assessments to diagnose and/or monitor the quality of regulatory processes of individuals and to use such information to guide subsequent training, teaching, or coaching efforts.

DISCUSSION

The primary purpose of this systematic review was to examine the characteristics of SRL microanalysis assessments and their application across diverse domains tasks, and populations. In addition to being the first study to systematically review SRL microanalysis research, this study shed light on recent trends in microanalysis applications (e.g., diagnostic, instructional, or intervention tools). From our perspective, the broad array of microanalysis applications across domains and domain-specific activities and populations along with its utility in facilitating treatment planning and evaluation, underscore its inherent flexibility and potential for use in practice by K–12 or college educators, clinical practitioners, athletic coaches, and perhaps administrators.

SRL Processes and Microanalysis

Our first objective was to examine the types and range of SRL processes targeted in microanalysis studies. Broadly speaking, we found that microanalysis assessments generate useful information when applied in a comprehensive (i.e., focus on all three SRL phases) or a more narrow fashion (i.e., focus on only one SRL phase). Approximately 50% of the studies targeted all three phases of the cyclical model of SRL (i.e., forethought, performance control, and self-reflection), while a third (33.33%) focused more narrowly on processes within a single phase. The fact that the largest percentage of studies focused on all three phases is encouraging and promising from both a theoretical and practical perspective. Most contemporary theories of SRL and regulation-related interventions underscore the interdependence among multiple phase processes, and emphasize the need to focus on multiple phases and processes to optimize student functioning across domains and learning activities (e.g., Cleary et al., 2017; Dignath & Büttner, 2008; Graham & Harris, 2009; Montague et al., 2011; Panadero, 2017). However, more "narrow" forms of microanalysis are also quite relevant and informative, as they generate data about important "aspects" of regulation, such as how students plan before beginning a science investigation or how they reflect on feedback about a mathematics exams. Callan and Cleary (2018) focused exclusively on performance phase processes (i.e., learning strategies and self-monitoring) among middle school students during mathematics problem-solving while Andrews et al. (2018) focused specifically on self-reflection processes (i.e., self-evaluation, attributions, adaptive inferences) of medical students after answering a vignette-based test question.

Another important finding was the frequency with which studies included in this review focused on self-reflection processes. Given that self-reflection of performance outcomes and processes tends to be an underutilized aspect of classroom discussion and learning activities in schools (Cleary, 2018; Spruce & Bol, 2015), it was interesting that over 90% of the studies focused on this phase, with a very large percentage of these studies (approximately 84%) specifically targeting student attributions. Attributions represent a critical regulatory process due to its motivational properties and link to adaptive or maladaptive reactions to challenging circumstances (Graham & Taylor, 2016; Weiner, 2010). Implementation of microanalysis approaches in schools might guide teachers and other school personnel in the provision of student self-reflection opportunities that can lead to improved teacher-student interactions, student motivation and outcomes.

Implications for School Practice

Another key finding was that SRL microanalysis has been used in a highly flexible and adaptable manner across diverse populations, domains (i.e., academic, clinical, athletic, and music), and activities (see Table 5). From an educational or school psychologist perspective, it was particularly relevant that microanalysis was applied to a wide array of *academic* (e.g., studying, test taking, test reflection, mathematics, problem-solving, writing, and reading) as well as *nonacademic* tasks (e.g., basketball shooting, kicking a soccer, diagnostic activities, or playing musical instruments) within school settings. Thus, teachers of various disciplines (e.g., content area, physical education, music) and school personnel (e.g., school counselors, school psychologists, speech and language therapists, interventionists) may find these assessment approaches useful when interested in assessing students' regulatory skills for activities aligned with their professional role.

Microanalysis approaches can be tailored by school personnel to identify individual student regulatory skill needs in situations that are relevant to students' everyday academic lives. For example, school psychologists may design and implement a microanalytic process with students at risk for reading disabilities to assess how an individual student prepares for tasks (e.g., assignments, test) that are cognitively and emotionally challenging (forethought phase). Microanalysis data can identify the specific strategies a student uses and how strategies are implemented during authentic learning tasks (performance control phase). Likewise, school psychologists can engage a student in self-evaluating their performance and collaborate with the student on using data to create plans for accomplishing goals during future learning (self-reflection). Within a consultative and coaching process with classroom teachers and/or parents, the ongoing use of microanalysis data could enhance the identification of unique student regulatory needs, formulate data-specific goals, create intervention plans and monitor implementation and progress towards goals to maximize student outcomes (Reddy et al., 2020). Taken together, the collaborative, formative, and flexible nature of microanalysis could bolster school personnel and student problem solving, mastery, confidence and well-being.

Taken together, the collaborative and flexible nature of microanalysis could bolster school personnel and student problem solving, mastery, confident and well-being.

Our results were also important from a systemic perspective, particularly in relation to intervention planning and development in schools. One of the most frequent uses (approximately 66% of studies) of SRL microanalysis was to differentiate treatment groups in intervention studies or naturally occurring group studies, such as high and low achievers or gifted and nongifted students. Its use as an outcome in experimental or intervention studies is particularly important because it underscores the sensitivity of microanalysis to detect intervention effects. In fact, there is some evidence that microanalysis measures are more sensitive than the more commonly used self-report questionnaire. For example, in a recent randomized control trial with middle school students, Cleary et al. (2017) examined the effects of a comprehensive self-regulation intervention program across motivational, strategic, and mathematics outcomes. While the authors found intervention and control group differences in strategic thinking and processes as measured by microanalysis, the groups did not differ across several self-report measures targeting similar processes.

In addition to evaluating intervention effects, microanalysis assessments have increasingly been used as a formative assessment tool for guiding instructional or intervention initiatives. Approximately 17% of the studies in this review examined how SRL microanalysis data can be used to positively influence the planning and implementation quality of instruction, coaching support, or implementation fidelity; that is, data reflecting consequential validity. As an illustration, in a recent multiple case study, Peters-Burton et al. (2020) utilized SRL microanalysis assessments to examine the process through which high school science teachers learned about content knowledge related to argumentation, and developed lessons plans that infused argumentation principles. The PD experience included two cycles; one reflecting content learning of argumentation principles with the other cycle pertaining to pedagogical content knowledge (i.e., how to effectively infuse argumentation during classroom instruction). SRL microanalysis assessments were administered for each of these cycles to examine the quality of teachers' regulation during the PD activities while also providing information about changes in these SRL processes over time. The authors noted that the microanalysis data increased

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teacher awareness of ineffective goals or strategy use and prompted their own attempts to refine these processes. The data also concurrently prompted the PD instructors to modify PD experiences and activities to address challenges encountered by teachers (Peters-Burton et al., 2020).

In the context of a case study, McPherson et al. (2019) examined the formative use of microanalysis assessments to enhance the quality of musical instrument practice for two first-year music students who differed in the quality of their audition scores (high vs. low score). By administering microanalysis assessments during practice, the researchers gathered information about the students' overall approach to practice and their use of SRL strategies. Although the SRL process of the two students were quite distinct, the authors were able to use the microanalysis data collected at three time points to enhance the awareness and reflection of each student regarding how to best improve their playing.

In addition to consequential validity, this review was important because it summarized the extent to which researchers have gathered data to support the validity of inferences from SRL microanalysis scores. The key types of validity evidence observed in these studies included convergent (61.9%), concurrent (66.7%), and predictive validity (9.5%). General findings were that microanalysis processes were consistently related with performance and achievement outcomes and emerged as stronger predictors of student performance than broad-based measures of SRL (Cleary & Callan, 2018).

Taken together, findings from this review underscore the premise that microanalysis assessments can be flexibly, efficiently, and effectively used with a range of populations, domains and activities in school settings. The adaptability and potential formative nature of microanalysis is particularly valuable for school personnel who must identify student skill needs and support student learning and growth in diverse and changing situations.

Directions for Research

Findings from this review offer suggestions for future development and validation of microanalysis assessments in schools. We highlighted possible task-specific constructs for microanalysis development that are reflected in theoretical models of SRL along with the broader multidisciplinary literature (see Table 1). Building off this literature, additional task-specific constructs may include *self-evaluative standards* and other types of task-specific reflective judgments, such as *perceived challenges* or difficulties. It is also relevant for researchers to further consider the development of *task analysis* questions that can directly target student perceptions about understanding task demands and challenges.

The value of SRL microanalysis assessments can be captured through a comprehensive validation that examines consistency of scores (reliability), inferences that can be drawn from sets of scores (construct validity), and consequences of using sets of scores over time in routine school practices (external validity). Likewise, the establishment of microanalysis reliability and validity evidence must consider the purpose, users (i.e., educators, students), tasks, and domains in which it will be used in schools. Similar to other school-based assessments, scores generated must demonstrate adequate internal consistency (i.e., how well items fit together), as well as other forms of reliability evidence, such as the stability of ratings over time (i.e., test-retest) and consistency of user ratings within and across contexts or during points in time (i.e., interobserver reliability).

While this review found that convergent validity data was commonly targeted, this form of validity warrants additional investigation. Future validation of microanalysis assessments should examine the degree to which microanalysis scores converge with scores from other events measures of SRL (e.g., think aloud protocols, direct observations or traces) and diverge from scores of unrelated constructs (e.g., personality). Also, microanalysis assessments should test validity evidence for response processes. Response processes refer to whether school personnel utilizing SRL assessments respond to or interpret it as intended. While this form of validity may be challenging to obtain, it does offer important insight on the commonly observed regulatory phases and processes students use in problem solving and learning in schools. Such evidence may be gathered in different ways, such as data from multiple school users or analyses of correspondence between ratings of educators and students.

As shown in this review, although there is substantial evidence that microanalysis processes related to performance outcomes, there is a need to examine the predictiveness of microanalysis scores to more distal student outcomes (i.e., predictive validity). Only 4 of the 42 studies generated predictive validity evidence. Similarly, it is relevant to examine reliable estimates of change or growth in student regulatory processes over time. Similar to student formative assessment, microanalysis assessment approaches need to reliably capture SRL phases and processes across multiple time points. The degree to which microanalysis scores obtained from repeated measures reflect actual rates of change in SRL processes is an important prerequisite for improving educator intervention implementation (fidelity) and student goal attainment.

It is also relevant for future research to examine microanalysis assessments sensitivity to intra- and interindividual differences in measuring SRL specific regulatory processes. We recommend that in the development and validation processes of any new microanalysis tools, efforts will be made to gather evidence on school personnel's perceived usability, feasibility, and sensitivity to change following professional development (e.g., coaching intervention). Studies that examine the efficacy of instructional coaching models that use microanalysis data to guide coaching decisions for educator and student improvement would be beneficial. Similarly, architects of new microanalysis assessments are encouraged to consider not only the utility and feasibility of methods, but also the scalability of use in schools. We suggest that new microanalysis assessments be designed with technology in mind to support school users in the administration, data storage, scoring, and graphic reporting of data. Reducing logistic burdens in assessment implementation will enhance the quality of data obtained and decisions made for improving intervention planning that lead to meaningful educators and student outcomes.

Finally, it is important for future studies to consider the use of meta-analysis procedures to quantitatively assess the nature or size or SRL outcomes achieved within and across different study designs. Likewise, studies are needed that assess how specific SRL processes impact implementer and student outcomes, as well as possible factors that mediate or moderate SRL intervention implementation and intended outcomes.

LIMITATIONS

This study had several limitations that warrant further attention and discussion. First, although we intentionally used inclusion criteria to restrict our pool of studies to those that adhering to the structural and content guidelines for SRL microanalysis assessments put forth by Cleary and colleagues, there are other programs of research that target motivational or regulatory processes using situationally specific questions administered as individual complete specific tasks (e.g., self-efficacy, judgment of learning; Chen & Bembenutty, 2018; Dunlosky et al., 2005). While these lines of research are informative and comprehensive, they are distinct in purpose and may serve as a complementary tool to microanalysis. Second, we also acknowledge that this review may not have included research studies that did not specifically use the term microanalysis.

Third, we did not use methodological characteristics as part of the inclusion criteria given that we wanted to examine the full range of purposes and applications of this assessment approach. Although this review approach allowed for a greater level of inclusion, it is entirely possible that the overall quality and rigor of research design varied across the peer-reviewed journal articles and student dissertations. Ultimately, we elected to include studies with more diverse qualities to most accurately and comprehensively represent the empirical literature and to guard against publication bias, a phenomenon widely studied for decades (e.g., Cooper, 2017). Finally, although we utilized a rigorous process for coding variables in this study and used consensus building to ensure agreement, we did not calculate inter-coder reliability throughout the coding process.

CONCLUSION

There is a growing literature base regarding SRL microanalysis methodology. In addition to being inherently flexible and dynamic in its measurement of SRL processes, it has been successfully applied to a range of domains and activities relevant to educators and other school support staff and personnel. This review builds on this important literature and offers a springboard for future measurement development and validation efforts for school-related settings. Additionally, the utility of formative assessments such as microanalysis in job-embedded coaching warrants further development and investigation.

DISCLOSURE

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Note. References with an * are ones included in the review of this study.

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Amanda Austin is a 4th year doctoral student in the school psychology program at the Graduate School of Applied and Professional Psychology (GSAPP) at Rutgers University. She has worked on Dr. Timothy Cleary's research team since beginning at GSAPP in 2017. Her primary areas of interest are applied behavior analysis and organizational behavior management, and her doctoral research focuses on compassionate supervisory practices and burnout in autism providers. For the past two years she has been working toward her BCBA certification, and she hopes to one day start her own autism center.