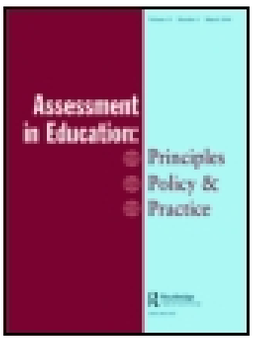

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A framework for classroom assessment, learning, and self-regulation

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ABSTRACT

We present a conceptual framework that leverages synergies between classroom assessment (CA) practices and self-regulated learning (SRL) theory to support academic growth and instruction. We articulate the processes shared by CA and SRL, drawing on a model of SRL with three phases: forethought, performance, and self-reflection. We blend this SRL model with CA to create the CA: SRL framework in four stages: (1) pre-assessment, (2) the cycle of learning, doing, and assessing, (3) formal assessment, and (4) summarizing assessment evidence. We elucidate how SRL processes are involved at each stage and can be drawn on to support learning development and teacher understanding and co-regulation of learning. This framework is important in that it depicts how assessment and learning processes interact dynamically for both teachers and students in classrooms, and demonstrates that such interactions encompass the full breadth of purposes in CA, from planning through summation of evidence.

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Classroom assessment; self-regulated learning; assessment for learning

Through classroom assessment (CA), both teachers and students gain information about student learning and teacher instruction. The teacher role in CA is to formally and informally gather information about individual student and group achievement relevant to learning in a content area. Teachers use this information to make instructional decisions for learning improvement. They also use CA to refine their own pedagogy and to communicate with students, their guardians and local school leaders about academic outcomes. Students use information from CA as a check for their own understanding, to help them plan learning strategies and understand areas where they can improve. Recently, researchers have begun to articulate overlapping rationales and processes applicable to both CA and self-regulated learning (SRL), based on cognitive, metacognitive, behavioural, and motivational principles (Bonner & Chen, 2019; Clark, 2012; Panadero, Andrade, & Brookhart, 2018; Wiliam, 2007). In addition to shared principles, both CA and SRL are iterative in nature, achieving their impacts through processes where learners have multiple opportunities to narrow their learning gaps, and to implement and refine their SRL strategies.

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Although there is a surge of interest in blending theories and principles of CA and SRL, we have identified several theoretical and practical limitations in current research. First, we identify a need for a model that takes into account the multiple purposes of CA. Most if not all of the theoretical work that has been done so far to connect SRL to CA has been limited to the assessment for learning (A*f*L) purpose (Clark, 2012; Panadero et al., 2018; Wiliam, 2007). The term A*f*L refers to those information-gathering processes that provide feedback for direct support of learning, either when teachers assess students or students self-assess. Various meta-analyses and syntheses of literature differ in estimates of the magnitude of the effect of A*f*L on student learning, but the general consensus is of some positive effect (Bennett, 2011; Black & Wiliam, 1998; Briggs, Ruiz-Primo, Furtak, Shepard, & Yin, 2012; Kingston & Nash, 2011; McMillan, Venable, & Varier, 2013). This general trend towards positive impacts is accompanied by great variability, requiring a nuanced approach to the study of A*f*L. For instance, Fyfe and Rittle-Johnson (2016) found that student characteristics affected the usefulness of feedback: immediate verification feedback had negative effects for students who had prior knowledge, but positive effects for students who did not. The impacts of peer assessment are similarly complex. Recently, Könings, van Zundert, and van Merriënboer (2019) found that peer assessment scaffolding had a positive effect on accuracy during learning, but a small negative effect on performance on test tasks. The researchers proposed that peer assessment may actually inhibit learning outcomes when it is introduced too early in the development of domain-specific knowledge.

However, A*f*L does not include CA purposes that are related to the evaluation, recording, and reporting of student achievement at the end of an instructional cycle or program of study. These purposes, typically referred to as summative, are often explicitly contrasted with A*f*L, with a preference in the field for A*f*L. Discourses about CA have thus far not found a balance between the formative and summative purposes, and there is tension between them (Bonner, 2016; Pope, Green, Johnson, & Mitchell, 2009). Assigning grades is a case in point. Over an extended period of time, teachers compile numerous pieces of evidence of students' work, and translate some of these pieces of evidence into marks or grades, which they report to others. Such a translation of the teacher's perception of multiple performances to an evaluative communication is common in most educational settings, though the consequences associated with teacher marks vary by context. A*f*L alone does not capture this complex shift of judgement between purposes.

Practical implementation presents a second obstacle to successfully and usefully blending CA with SRL. Although empirical studies on SRL have shown benefits for students who learn SRL strategies and have opportunities to engage in self-regulation (DiGiacomo & Chen, 2014; Michalsky, Mevarech, & Haibi, 2009), SRL is rarely taught in classrooms (Lawson, Vosniadou, Deur, Ayra, & Jeffries, 2018). This is unfortunate, because without explicit instruction in SRL, students do not naturally develop more or better SRL strategy and use as they mature. Instead, students continue to use their partial and sometimes faulty knowledge of strategies. The low incidence of explicit instruction in SRL may partly be due to teachers' incomplete understanding of student SRL, and how to support it. Lawson et al. (2018) noted that pre-service teachers' knowledge of learning strategies was generic, and that they did not articulate why the strategies they mentioned would support learning. They also reported that in-service

teachers rarely integrated explicit SRL strategies into their instruction, although they were familiar with and endorsed views about learning that are consistent with SRL. This kind of disconnection between SRL theory and educational practice is but one instantiation of weak impacts of tested theories on practice, which researchers in education often lament. We, therefore, stress practical approaches to incorporating opportunities for students to develop their SRL through intentional assessment design.

We propose a framework that involves CA and academic SRL which we refer to as CA:SRL. Viewed as a 4-stage, iterative process as well as a design framework, CA:SRL allows us to highlight processes shared by CA and SRL, and present SRL concepts in a new way, within the larger context of all assessment activities that occur in classrooms. To explain our framework, we present the theoretical basis for our conceptualization of SRL. We then describe the CA:SRL model, relating each stage to elements of CA that support valid interpretation and use of information, as well as to its focal SRL process. We note here that at some stages all SRL processes likely occur, while at others, some processes and subprocesses may be imperceptible to the conscious mind. Throughout, we emphasize that CA and SRL are both iterative: even the act of summation is not final in the classroom context, but provides information that impels (or impedes) learning. We also discuss three essentials that structurally bind and connect the stages of our model: inference, feedback, and use. We believe that designing CA processes with SRL in mind can bridge the gap between theory and practice, involve students in assessment in a way that encourages them to sharpen their SRL knowledge and practices, and bring summative purposes of assessment better into the fold of CA.

Theoretical framework of CA:SRL

Self-regulated learning

SRL is a complex and multifaceted construct that describes how learners initiate, strategize, and sustain actions to achieve their desired learning goals. SRL has been widely researched, and the literature includes many models that share similar elements and processes (Efklides, 2011; Pintrich & Schunk, 2002; Winne, 2018; Zimmerman, 2002). Based on empirical research and a social-cognitive framework, Zimmerman (2002) developed a cyclical model of academic self-regulated learning that consists of various SRL processes that learners purposely use to manage their behaviours, cognition, emotions, and environment to attain personal goals (Figure 1). His SRL model has been empirically researched and applied to the learning of various disciplines, such as mathematics (Chen & Zimmerman, 2007); sciences (DiBenedetto & Zimmerman, 2013), sports and athletics (Cleary & Zimmerman, 2001; Kitsantas & Zimmerman, 2002), and health (Zimmerman, Bonner, Evans, & Mellins, 1999). Students who are self-regulated in their learning exhibit heightened motivation and metacognitive awareness, and incorporate self-feedback and external feedback (e.g. from teacher, peers, and parents) to appraise and adjust their learning strategies and actions. SRL is a dynamic and continuous feedback mechanism that is vital to education because it signals to learners that the potentially useful information they acquired during one phase can guide and adjust their plans and behaviour for the next phases of the learning cycle (Zimmerman, 2002).

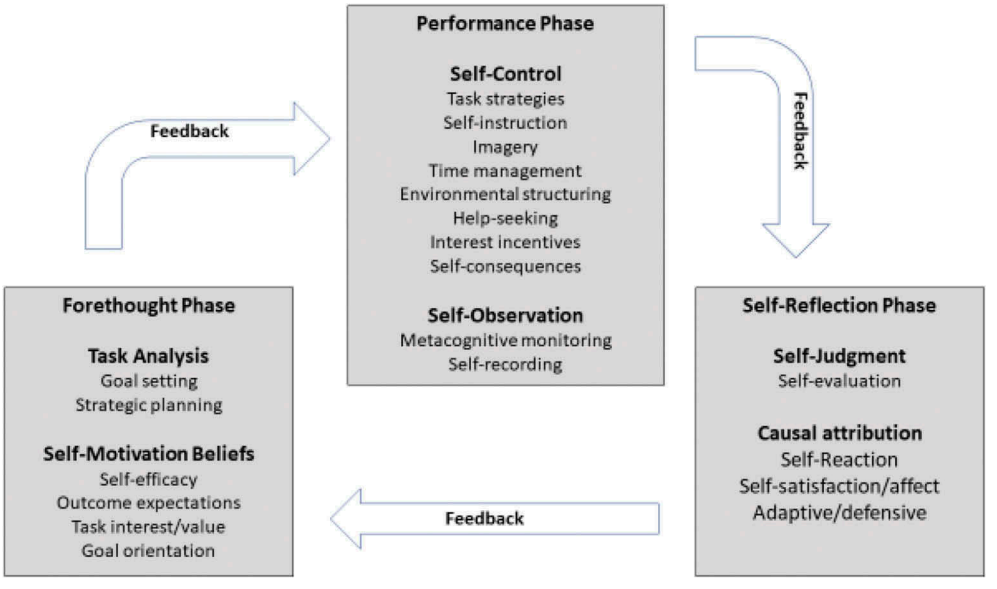

Figure 1. Zimmerman's SRL model.
Adopted from Zimmerman and Moylan (2009)

We have adopted Zimmerman's (2002) model rather than other well-known frameworks (e.g. Efklides, 2011; Pintrich & Schunk, 2002; Winne, 2018) because it takes into account the dynamic and reciprocal exchanges between, personal, behavioural, and environmental factors. Most important, Zimmerman's model is informed by social-cognitive perspectives of learning and balances the motivational, cognitive, metacognitive, behavioural, and social aspects of learning. Because classroom settings and learning are social and interactive, a social-cognitive model of SRL is germane to understanding how learning takes place in them. The Zimmerman (2002) model highlights the iterative nature of learning and is unique in delineating the behaviours, cognitive and metacognitive processes, and motivational elements that learners experience as they pursue their learning goals.

In Zimmerman's model, a learner begins with *forethought* – setting the stage before engaging in the learning event or task. The forethought phase refers to learners' attempt to assess their prior exposure to the content, to conduct task analysis, to select best strategies, and to set attainable goals and sub-goals. Specifically, this forethought phase involves task analysis processes such as goal setting (e.g. prioritizing immediate and distal goals), strategic planning (e.g. selecting appropriate strategies for the tasks at hand), and self-motivational beliefs (e.g. self-efficacy beliefs, outcome expectancies, and task interests and values). At this phase, learners conjure up various motivational beliefs such as self-efficacy, intrinsic interest, goal orientation, and outcome expectancies. Although many motivational beliefs are important, self-efficacy beliefs and outcome expectancies play key motivational roles in learners' choice of goals and their subsequent effort and persistence in attaining them. Before diving into a challenging and novel academic assignment, students analyse the task before them and assess their motivational beliefs (such as their capabilities to complete the task), and plan what

strategies they may use to achieve success. Processes during the forethought phase influence students' approaches to engaging in the performance or doing of learning, as well as their ability to succeed in this.

The second phase, *performance*, occurs while learners engage in the task and involves their self-control (e.g. attention focusing, strategizing, and seeking help if needed). During the performance phase, self-regulated learners also engage in self-observations, such as self-recording and metacognitive self-monitoring. Zimmerman (2008) distinguishes between metacognitive self-monitoring and self-recording. Metacognitive self-monitoring is more general and involves a cognitive focus and attention to one's progress, while self-recording involves deliberate and more formal, systematic monitoring of the aspects of learning or performance. Self-recording often involves tracking performance scores in written form, checking completed actions taken, and charting or graphing progress on targeted behaviours (DiGiacomo & Chen, 2014; Kitsantas & Zimmerman, 2006). When students self-record their progress, they create important feedback in relation to their self-set goals.

Self-reflection, a uniquely human quality (Bandura, 1986), is the third phase of Zimmerman's SRL model. In self-reflection, learners examine and evaluate their performance and make adjustments for future learning events or tasks. The processes in this phase include self-judgments (e.g. evaluating one's performance and making causal attributions to the results) and self-reaction (e.g. the extent to one is satisfied or dissatisfied with their outcomes and their adaptive or defensive self-reactions to those outcomes) (Zimmerman, 2002). Self-evaluation is a form of self-judgment in which learners compare their performance to self-set standards. To determine the effectiveness of the strategies they used during performance and for future improvement, they need to self-evaluate and examine their performance, as well as the processes that led to a particular outcome. Causal attributions, a concept originated by Weiner (2010), are the other feature of self-judgment. Learners' beliefs and explanations about why certain outcomes occur, or the locus of causes, can affect learners' self-feedback. As seen in many classes, successful and unsuccessful learners differ in the way they perceive setbacks or failures – whether they consider them internal/external, controllable/uncontrollable, and stable/unstable over time.

It is important to note that the 'self' in SRL, as conceived in much of the literature, refers to the individual learner or student. Furthermore, SRL processes are often viewed as internal processes that the individual engages in when learning or working alone on complex tasks. However, Zimmerman's SRL is an interactive and dynamic social-cognitive model. Therefore, in our CA:SRL framework, we also discuss the 'self' in self-regulation to include teachers. In a social environment such as a classroom, one's SRL and learning is inevitably influenced by others.

Because of this social and interactive nature of SRL as applied to CA, in the 4-stage CA:SRL framework we draw on the concepts of socially *shared regulation* and *co-regulation* of learning (Hadwin, Jarvela, & Miller, 2018). These constructs of regulation are still nascent, and research on them is scarce. Conceptually, however, they complement SRL, which focuses on 'self' learning. In a classroom setting, shared regulation refers to how a group of learners work toward a goal or the same learning outcome by planning together, making strategic decisions, acting on the plan they choose, metacognitively monitoring the group's progress, and reflecting on the group's performance.

Shared regulation is observed when students engage in collaborative group work to attain and accomplish a common outcome or goal.

Hadwin et al. (2018) further describe co-regulation as how learners' self-regulation is influenced (promoted or constrained) by their interactions and exchanges with others (e.g. teachers) during their learning or engaging in tasks. When engaging in co-regulation, learners' own SRL processes are affected by others (and vice versa) and the co-regulators' goals are not necessarily the same; thus, support and prompts from teachers can help students use SRL strategies and develop their fluency with SRL processes (Hadwin et al., 2018). Another way to describe the co-regulation concept is by using an example: when students work together to solve a math problem, the ideas that group members contributed are based on individuals' own agency and processes of SRL. In the same working group, members could offer suggestions to others about how to proceed in reaching the goal or outcome, but the group's synchronicity is affected by individuals' inputs rather than reaching the common goals. In this case, each learner reacts to other members' inputs according to how consistent the co-regulation is compare to each member's own SRL processing.

Iteration is a key characteristic of SRL models, and is prominent in Zimmerman's model, where learners make adjustments from one cycle to the next. Students initially engage in a cycle of SRL when they face a challenging and novel learning endeavour; after the first cycle, SRL continues as students perform within a domain multiple times, with incrementally more complex tasks in the domain. Writing an essay, for instance, involves iterative performance, as writers engage in forethought, performance, and reflection repeatedly over many stages of the writing process: forming a thesis, outlining an argument, collecting evidence, constructing a first draft, and revising drafts until the writer believes that the paper has met their goal. Learners may vary in the number of iterations they require to attain their goals according to the complexity of the task domain, as well as due to individual differences in prior knowledge and motivation. However, goal-attainment on complex tasks that are well targeted to learners' needs likely requires several iterations of performance.

The framework: CA:SRL

CA:SRL blends the core aspects of SRL with activities that are part of CA practice. As a subfield in the domain of measurement, CA comprises a wide variety of activities that teachers perform in order to obtain, analyse, interpret, and use information about student learning. As with other educational assessment, characteristics of the activities associated with CA relate to the validity of the inferences about learning that are drawn from the information, and the validity and fairness of information use. Drawing high-quality inferences requires attention to the assessment purpose, the content domain, the assessment tasks themselves, the evidence they produce, and the psychological processes that ground the student performance and teacher interpretation about that performance. In classrooms, teachers have great leeway in assessment content, methods, and interpretations. Considering teachers, therefore, as assessment-developers, we suggest that teachers' assessment activities should be guided by principles like those set forth in the *Standards for Educational and Psychological Testing* (AERA et al., 2014; hereafter, *Standards*), although necessarily adapted for classroom contexts (Bonner,

2017). The CA:SRL framework provides guidance for developing assessments so that they will be aligned to the assessment purpose and also support student self-regulation.

CA:SRL has four stages: (1) pre-assessment, (2) the cycle of learning, doing, and assessing, (3) formal assessment, and (4) summarizing assessment evidence (Figure 2). Each stage represents a necessary part of CA, from precise identification of the content domain for instruction and assessment, to the gathering of multiple sources of evidence in instructionally sensitive ways, to formal assessment of performance, to summation of multiple strands of evidence. In each stage, students and teachers engage in distinct SRL processes as they interact over assessment tasks. As shown in Figure 2, arrows between the stages illustrate the processes wherein teachers and students draw inferences from evidence, provide and receive feedback based on those inferences, and use those inferences to guide behaviour in the next stage. The model is cyclical, when summarization and reflection on a set of evidence from a cycle of assessment on a set of related instructional objectives have been performed, planning for new instruction and assessment gives rise to new pre-assessment and forethought.

Stage 1

Stage 1 of the CA:SRL framework comprises pre-assessment and SRL forethought. Assessment development begins with planning: articulation of the intended purpose, construct identification and delineation (AERA et al., 2014; Haladyna & Downing, 2011; Messick, 1994). In a classroom context, teachers begin to plan assessment with their content-domain standards, but must then narrow the domain to a scope that is appropriate for the particular social context in which they teach. This narrowing of the domain may, and should, involve pre-assessment. Prior knowledge of student needs provides essential guidance in CA design, although it does not override academic

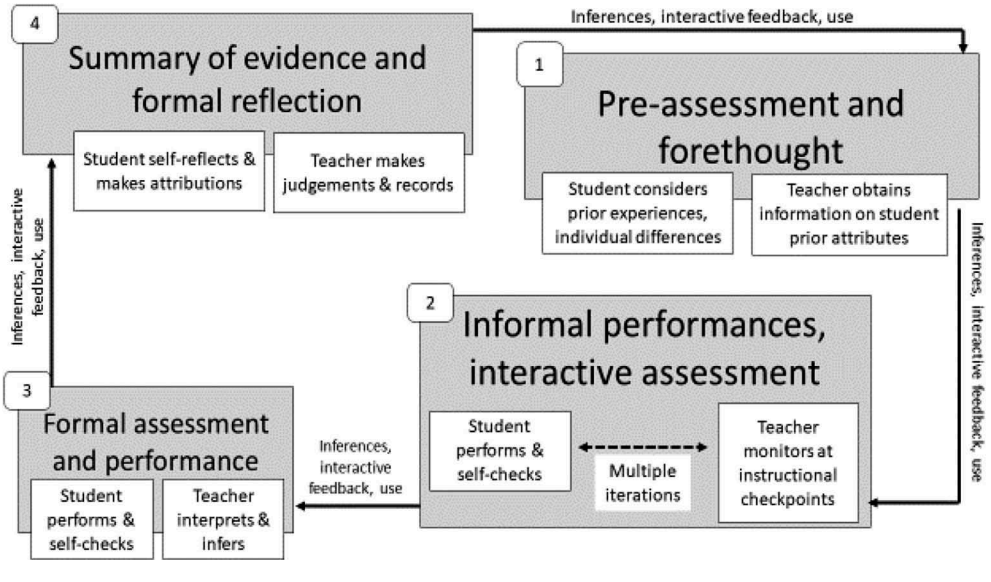

Figure 2. CA:SRL Framework.

standards. Validity of assessment interpretations (and good instruction) is contingent on a fit between the group assessed and the assumptions that were built into the assessment design (AERA et al., 2014; Kane, 2006); therefore, in CA, a teacher should not embark on a plan of instruction and formal assessment without verifying assumptions about student learning through pre-assessment.

Pre-assessment helps teachers learn about what students know and can do, and about students' motivation and attitudes. This stage involves teachers in forethought, as they delineate and refine the content-domain to be covered in ensuing instruction and the next stages of assessment. Information gathered at this stage can help teachers decide how to pace their instruction (including coverage of prerequisites) and identify student misconceptions about the learning content. Teachers can use pre-assessment information to identify student attitudes or preferences that can be used as leverage points to build on enthusiasm and make instruction more meaningful to students. Pre-assessment of motivation helps teachers to identify and plan to address social-emotional obstacles to learning.

Classroom pre-assessment also helps students, by strengthening the metacognitive skill of forethought in SRL. A pre-assessment task of content-relevant knowledge or skills can ignite student forethought at the very start of an instructional cycle. Well-designed pre-assessment encourages students to mentally analyse content in upcoming learning and think of strategies they can use. Learners may engage in task analysis processes such as goal setting (e.g. prioritizing goals to reach longer-term goals successfully) and strategic planning (e.g. selecting or creating appropriate strategies to complete the target task). When teachers elicit student thinking through task analysis in pre-assessment, they gain access to information about students' current strategies and metacognition that they can use to plan their upcoming pedagogical approaches.

Also, when students are presented with a pre-assessment task of content knowledge or skills, they can be asked to judge their confidence in performing the task. Following the pre-assessment, they can compare these prior judgments to their actual performance. This serves to provide self-feedback for students. Correspondence between a person's confidence judgments about doing a task and his or her actual performance on a given assessment task is referred to as *calibration* (Hacker, Bol, & Keener, 2008). When students overestimate their capabilities or are overconfident about their skill sets, they may not engage in self-regulated learning behaviours or implement the strategies needed to succeed academically (McGuire & Kable, 2016). The underlying processes of student calibration during the pre-assessment stage, particularly in making *prediction* judgments (i.e. making confidence judgments before solving the task) can be considered broadly as the student's execution of metacognitive knowledge and systematically monitoring their learning at the very beginning stage of their learning and assessment. Allowing students to practice calibration at the pre-assessment stage helps support development of self-regulated learning.

Motivational beliefs are also important factors that influence learning during forethought. Motivation influences how people set goals and plan for subsequent actions. Teachers can pre-assess student motivation to learn what they believe about their capabilities to successfully tackle problems, or how interested they are in the problem at hand and how much they value learning it. Other motivational beliefs related to the forethought phase in Zimmerman's SRL model include outcome expectancies and goal

orientations. Outcome expectancies are personal beliefs about an anticipated action or performance. Students who have good academic self-regulation have positive outcome expectancies. For example, this is a positive outcome expectancy about an external outcome: 'If I study harder, I will earn a good grade on the reading test.' A positive outcome expectancy about an internal outcome is: 'If I study harder, I will feel good about myself as a reader.' Also, students hold different reasons for engaging in a learning task: they may genuinely enjoy it, they may want to get an A, or they may hope to impress their teacher with their knowledge. These different reasons or schemas constitute a student's specific learning goal orientation (Kapan & Maehr, 2007; Zimmerman & Moylan, 2009).

There are important benefits to students when they develop SRL skills during the forethought phase. Learners who engage in good planning and goal-oriented strategising are self-motivated. Learners with SRL skills are likely to have higher self-efficacy in comparison to others. By self-efficacy, we mean confidence that they will be able to successfully execute a task at hand. Researchers have demonstrated the importance of SRL forethought processes in influencing academic performance (Zimmerman, Moylan, Hudesman, White, & Flugman, 2011; Zimmerman, Schunk, & DiBenedetto, 2015). Research has shown self-efficacy beliefs to be one of the best predictors of students' academic performance in areas such as math, writing, performing arts, and sciences (McPherson & McCormick, 2006; Pintrich & De Groot, 1990; Schunk, 2003). Students who calibrate well are more likely to attain desired goals, whereas students who are poorly calibrated in their performance tend to overstate their confidence levels or be overconfident (Chen & Zimmerman, 2007; McGuire & Kable, 2016).

Stage 2

Stage 2 is the cycle of instruction and assessment for learning, which connects to the SRL performance phase. Stage 2 emphasizes interactivity in performance between teachers, students, and peers, relatively informal assessment techniques, and multiple iterations. In Stage 2 CA, teachers purposefully design and conduct assessment activities in order to examine the effects of instruction. Therefore, they assess in ways that elicit performance frequently, almost concurrently with instruction, and at a grain level that matches the scope of learning to be assessed. Such assessments cover only small segments of a learning progression over the course of a unit of study, or small, semi-discrete groups of specific learning objectives; teachers use them to guide each next instructional step. While 'everything students do – such as conversing in groups, completing seatwork, answering and asking questions, working on projects, handing in homework assignments, even sitting silently and looking confused – is a potential source of information about how much they understand' (Leahy, Lyon, Thompson, & Wiliam, 2005, p.19), in order for information to be useful it must be acquired with purpose in mind. Administered in small increments, Stage 2 CA:SRL is highly iterative, as noted in the open line with double arrows in Figure 2. There is a great deal of back-and-forth exchange of information or feedback between students and teachers, with repeated cycles of instruction, checkpoints throughout assessment, and continuing instruction within this stage.

Assessment activities in Stage 2 should be designed to be instructionally sensitive and take place in tandem with learning activities. Here we refer to instructional sensitivity writ small, as it were. Instructional sensitivity refers 'the extent to which student performance on a test or item reflects the instruction received' (Polikoff, 2010, p. 3). Although we know of no studies of this kind of instructional sensitivity in CA, we propose that in order to show instructional sensitivity in CA, tasks must be designed to pick up small learning changes, progress, and new gaps as they are uncovered. Such tasks inform identification of current learning needs and provoke effective responses to identified needs. This requires continuous re-definition of important learning targets within the content domain as learning progresses, and teacher design of tasks that can elicit fine-grained information, such as demonstrations of isolated skills, and highly structured open-ended problems. Because teachers focus on learning in progress in Stage 2, they interact frequently with students during performance on these assessments, and encourage students to interact with their peers. Teachers provide within-task scaffolds as they identify areas where students struggle, and record those areas for instructional response.

During Stage 2, students are engaged in ongoing implementation of strategies to perform a task such as demonstrating a skill, or solving a problem. They exercise self-control and self-monitor their progress. Although Zimmerman (2000) posited the importance of metacognition in the performance phase of his SRL model, he did not present the mechanisms of metacognition as clearly as other theorists have. Specifically, we find Nelson and Narens' (1990, 1994) depiction of the interplay between self-monitoring and self-control to be clearer and more comprehensive from the perspective of cognition and information processing.

Nelson and Narens developed a dynamic theory of metacognition with a number of interrelated components. First, they conceptualized cognitive processes as existing on two levels: object-level and meta-level. The object-level consists of cognitive processes (e.g. 'This is a fraction divided by a fraction problem'), while the meta-level consists of metacognition, or cognition of the object-level (e.g. 'What does it mean to divide fractions?' 'Which strategy should I use to solve this math problem?'). Second, these authors conceptualized how information flows between the two levels. The meta-level governs, regulates, and acquires information from the object-level via monitoring. Monitoring signals the individual about the state of the object-level such as content knowledge, skills, or learning strategies. The meta-level sends information to the object-level via controlling or control actions. By exercising control, an individual can use their knowledge at the meta-level or metacognitive level to regulate or direct what to do or not to do at the object-level or cognitive level. Throughout the course of cognitive activity, object-level and meta-level processes simultaneously operate to deliver information (monitoring) and directives (control) between the object-level and meta-level. As in Zimmerman's SRL model, Nelson and Narens' model of metacognition is also goal-driven: the meta-level contains within its goals and possible ways to regulate the object level to accomplish those goals.

One benefit of asking students to perform multiple brief assessments is that it helps them exercise the kind of self-control described above. Students practice self-control in assessment when they draw diagrams; form imagery or mental pictures and map concepts; manage their time; set self-consequences to motivate their learning; structure

the learning environment to enhance learning and complete tasks; and seek help or information (Wolters, 2003). During multiple cycles of performance, students can also gain practice though self-observation processes. Self-observation includes metacognitive monitoring as described above (i.e. covertly and mentally tracking their learning progress and performance outcomes). Self-observation can also include explicit self-recording (i.e. overtly and deliberately recording and tracking their learning progress and performance outcomes).

Designing opportunities for students to practice self-observation at the performance phase of SRL is equally desirable for teaching and assessment. All learners implicitly engage in these metacognitive processes when they perform, but highly self-regulated students are more likely to do consciously or with better results than others. Therefore, to support student development of these crucial SRL skills, in Stage 2, teachers use tools like recording devices or checklists to aid students in monitoring their learning progress and accurately self-assessing their performance successes and gaps. The information generated during the performance phase then feeds back to the learner, who uses it to evaluate the effectiveness of their performance.

While students learn about their own learning, teachers learn about their students and monitor their developing knowledge and skills. While students implement their strategies to solve problems, teachers can gauge the progress of student learning through, for example, informal questioning, homework assignments, and student self-feedback and peer-feedback sheets. It is during Stage 2 that teachers often observe students' success in meeting learning criteria and note their alternative conceptions and patterns of mistakes, which afford further teaching and learning opportunities. This information helps teachers to know whether their instruction is effective in helping students meet learning goals. It helps to provide feedback to students that focuses on their specific learning needs. It helps to see if teachers' plans for pacing and differentiation, likely drawn from pre-assessment, are working; and it helps in deciding how to design formal assessment tasks that match students' learning experience.

The multiple iterations emphasized in Stage 2 of CA:SRL are a bedrock of assessment practice that is ongoing and interactive for all stakeholders in the classroom. We recognize that not all learning needs multiple iterations of instruction and assessment. As teachers are aware, not every topic in a content area is equally complex and difficult. If students already have a base of knowledge about a content area (say, long division), teachers might only need to lead instruction and assess students on one occasion to be able to gather enough evidence to infer, with a high degree of certainty, their students' current knowledge and understanding. If students have no reference point or familiarity with the content, teachers may need to engage in multiple iterations of teaching, assessing, and re-teaching differently. As Zimmerman et al. (2015) indicated, tasks that people have prior knowledge of do not require the same mental attention and extensive planning to execute as do novel and complex tasks.

In sum, Stage 2 comprises ongoing successive checkpoints of assessment, highly aligned to instruction and intended to gather information about rapidly evolving learning. Students' self-observation and monitoring processes help them develop into independent learners and yield important assessment evidence for teachers. The frequency of assessment in Stage 2 helps teachers translate information about students into prompt instructional responses that are targeted to current learning needs.

Stage 3

In this stage, students are formally assessed at a point of instructional closure – after the last of a series of lessons that are unified by the standards they address, for instance. The CA:SRL framework defines a place for formal assessment in CA not just because of classroom exigencies, such as the need to manage the logistics of learning and instruction by separating instruction into units and academic terms. Although we view learning and assessment as a continuous and iterative process, we also know that humans, particularly sophisticated self-regulated learners, need to pause and reflect. Periodic formal assessments provide a time for students to demonstrate what they have achieved and pave the way for the next phase, where students and teachers reflect on the learning and teaching that have taken place.

Stage 3 assessments tasks yield information about multiple objectives in a more broadly-defined content domain than Stage 2 assessment, and provide evidence to be used as part of marks or grades (Stage 4). As test-developers, teachers design Stage 3 tasks primarily in reference to academic standards, which is consistent with expectations under the *Standards* (AERA et al., 2014), which give primacy of place to content-related approaches. Design of Stage 3 assessment is also informed by all the evidence accrued throughout the previous stages in CA:SRL. This stage affords students an opportunity to demonstrate the cumulative knowledge and skill sets they have solidified incrementally by the end of an instructional period. The assessments developed and administered at this time typically assess combinations of learning outcomes that have been previously assessed more incrementally. Stage 3 assessments provoke students to engage in greater cognitive processing.

The quality of the design of assessment tasks and rubrics becomes a paramount consideration in Stage 3. Teachers design tasks that require complex strategies or combinations of knowledge and skill attributes, which can either be evaluated holistically or analytically. Stage 3 tasks also prompt learners to demonstrate their engagement in various SRL processes and metacognition. These tasks would present difficulties for a learner who had not been exposed to the multiple iterations of instruction and Stage 2 assessment, with corresponding opportunities for self-feedback and instructional responses. Stage 3 tasks are neither shallow nor unfamiliar; they require considerable metacognitive monitoring. Winne (2018) examined levels of information processes and depth of knowledge in relation to SRL processes. He articulated how various levels of information processing occur according to the SRL processes in each phase of his SRL. Winne's (2018) proposed that when the structure of information is more complex, it affects greater of SRL processing needed by learners. We extend Winne's theoretical proposition to Stage 3 CA:SRL, positing that formal CA should present complex structures that require more explicit monitoring on the part of students to perform. For fairness in CA, we note that students must have had an opportunity to learn (McDonnell, 1995) and to practice the structures both incrementally and in increasingly larger chunks during the prior stage where instruction and assessment occurred in tandem.

As with Stage 2, we place Stage 3 in Zimmerman's (2000) performance phase, with a different emphasis. Here, we emphasize the point at which students carry out a performance without teacher scaffolds or support. Performance during the cycle of

learning, doing, and assessing (Stage 2) is analogous to when children first learn to ride their bikes – many need training accessories and adults' scaffolding. At the closure of a period of instruction and learning, however, children have the opportunity to demonstrate whether they can bike without this extra support. In CA, we would say they are ready for formal assessment. In essence, at this pausing point in learning, we can see the extent to which students have the propensity and ability to engage in performance control processes without the scaffolding that supported them during the prior stage. During this stage and in terms of SRL, students should be independently practising self-control and self-monitoring. Teachers have helped them develop these skills during the cycle; during formal assessment, they will practice these skills on their own, without the assistance of external supports such as their peers, notes, or their teacher.

Stage 4

This stage refers to summarizing performance of student learning, which we map onto self-reflection in Zimmerman's SRL model. At this time, teachers and their students have gathered evidence of learning and have engaged in instruction and assessment cycles, likely multiple times. Students have performed on a formal assessment, and teachers pause between instructional units or time periods. Teachers and students now do two things: summarize and evaluate. Summarizing student performance entails combining all the information provided by multiple high-quality sources. Evaluating means considering the sum of the evidence and making judgments. Summarizing and evaluating student performance is the professional responsibility of a classroom teacher. An evaluative summary of student achievement is most often reported as a grade, but it can also be conveyed in other ways.

When teachers (or students, in self-assessment) prepare to summarize evidence and make evaluations, they should carefully consider and reappraise the quality of the evidence from the multiple assessments that will compose the grade or mark. This is an essentially reflective activity, whose fairness – taking fairness as part of validity in CA (Gipps & Stobart, 2009) – can be enhanced through student-teacher interactive reflection. Camilli (2013) suggests that with transparency and fairness in grading, teachers model and help students internalize fair use of authority, making assessment 'a model process for the students' participation in their communities and a larger democratic culture' (p. 116).

The self-regulation component of this stage of our framework should not be overshadowed by the official reporting function of summation of achievement. It is at this stage that we find, according to Zimmerman's theory, the greatest emphasis on self-evaluation and self-reaction. Self-evaluation refers to the judgment one makes of one's own performance in relation to a specific standard, as well as making causal attributions for the outcomes. Providing students opportunities for self-evaluation and reflection engages them in being metacognitive and in orchestrating their learning. This can be encouraged by asking students to self-assess. The underlying process of student calibration during this stage, particularly making *postdiction* judgments (i.e. making confidence judgments after completing the formal assessment) can serve as a way for

students to revisit their metacognitive and reflective processes that are pertinent to stage 4 of CA:SRL.

Self-reflection during Stage 4 not only adds an opportunity for students to reflect on their formal performance outcomes, but also affords them a holistic view of their learning and performance outcomes. Self-reaction refers to the learners' level of satisfaction or dissatisfaction with their performance and indicates their adaptive or defensive reactions to the outcomes (Zimmerman, 2000). Whether students engage in further learning and proceed to a next phase of forethought for new learning depends on these self-reactions. Self-reactions may affect some learners who experience negative self-reactions to a performance outcome: they may not willingly incorporate changes to their learning strategies, adapt other ones, or take teachers' feedback into account during the next iteration of learning cycle.

Teachers can help students to engage fruitfully in evaluating and judging their assessment performances by providing them with external standards or guiding them to set their own standards. Comparing students' work to standards and seeing the gaps or inconsistencies between their actual performance and these standards can affect students' attributions for their outcome. Students are likely to attribute their success or failure of performance outcomes based on internal sources such as their own intelligence or external sources such as teachers. Weiner's theory of attribution has provided a way for us to understand how students' attributions for their success or failure influence their subsequent actions and learning attitudes (Weiner, 2010). Similarly, knowing what sources students attribute to their performance outcomes can provide valuable information about their *mindset* of intelligence (Dweck, 2008). Children with a growth mindset are likely to see a less-than-stellar performance as an opportunity to improve. Children with a fixed mindset, on the other hand, attribute their outcomes to something that cannot be changed. Of course, teachers also make attributions for their students' performance outcomes. The reflection and summation part of our framework is a good time for teachers and students to check the consistency of their attributions.

Understanding how both teachers and their students make attributions for the student's performance outcome provides an opportunity for communicating and working together to best support the learners' needs for the next instructional unit or sequence of teaching, learning, and assessment. At this pause instruction, teachers are not only evaluating students. Teachers are also responsible for reflecting on and evaluating their teaching craft. While teachers make attributions about their students' performance outcomes, teachers also self-evaluate their instruction and adjust it to meet the instructional needs of their students. In addition, teachers should take an evaluative stance towards their own assessment practices and consider whether their evaluations of students are based on unbiased observations, accurate interpretations, and fair practices.

Teaching and learning are continuing processes that do not stop after students have been assessed and teachers have interpreted students' work. Reflecting this, the CA:SRL framework is cyclical, like Zimmerman's model of SRL processes. Inferences, feedback, and use connect each stage like 'glue,' and make the connection between Stage 4 and a second cycle beginning with Stage 1. Inferences, feedback, and use explain and guide

the actions that lead classroom learning and assessment from one stage to the next, as illustrated with arrows in Figure 2. The arrows are just as important as the boxes.

Inference as a key process in CA:SRL

Assessment is an inferential process. Teachers clearly care about what the students can do right now; therefore, they ask their students to do something right now. However, much of the time they are also interested in the behaviour as a more generalized attribute. The specific behaviour that the student performs in response to an individual assessment task is just a sample of the construct that teachers are trying to assess. We do not think teachers only want to know on one occasion whether students will remember to put on safety goggles before starting their science lab. Teachers want to know whether the student will generally wear safety goggles when performing laboratory investigations.

Generalizing in this way from a single one-time observation to a broader construct requires inference (Pellegrino, Chudowsky, & Glaser, 2001), a mental step. It starts with interpretation of the immediate evidence. Teachers and their students observe students' performance. The performance may be a very indirect measure of knowledge, such as circling one of several choices on a multiple-choice test. The behaviour may be a more direct assessment of the skill, like an observation of the actions the student performed as they began a laboratory activity. Whichever the case, the meaning of that performance must be interpreted. Does checking the wrong answer on a multiple-choice item mean that the student did not know the correct answer, or does it mean that the question itself was confusing? Did the student put on safety goggles because they knew they were supposed to, or because they saw another student doing so?

The quality of the inferences that teachers and students draw from the evidence about performance at each stage is often neglected in research on CA, although attention has been recently given to the issue (e.g. Bennett, 2011). However, the issue of validity of inferences matters greatly in CA, because inferences form the basis from which teachers feed back information to their students about what they have learned thus far, and what their next goals and plan for learning should be. With the CA:SRL model, we aver that teachers' inferences may be improved when they interact with students over assessment information through co-regulation of learning.

Feedback as a key process in CA:SRL

Interactive feedback in the 4-Stage framework is strongly aligned with Zimmerman's SRL theory. The 4-Stage CA:SRL framework involves multiple dimensions of feedback generated from students, peers, and teachers. Thus, we conceptualize the feedback loop in the 4-Stage framework to be interactive. Interaction in feedback is essential because assessment for learning and self-regulated learning require students and teachers to be active agents and purposeful in using feedback to move forward and take certain actions. All parties, whether they provide feedback or receive it, need to communicate about the usefulness and clarity of the feedback. Those on the providing end – usually teachers and sometimes pers – need to ask whether students understand and can learn

from feedback, because those on the receiving end (usually students) are the final arbiters of whether the feedback is useful for subsequent actions.

Feedback is particularly important in CA when students are developing self-feedback and peer-feedback skills. It is a mistake to think that feedback only comes from teachers: feedback is also self-generated and often involves peer interactions, even when such interactions are informal, such as when students compare grades or ask each other questions. To help students develop the skills to generate useful feedback, teachers can provide explicit scaffolds to help them learn self- and peer-assessment skills, and to communicate with them about the emerging quality of their self- and peer-assessment practices.

Research has shown that feedback is a critical component of learning that guides students and serves as a source of motivation (Shute, 2008). Feedback also has a regulatory function (Hattie & Timperley, 2007); as posited in Zimmerman's model, feedback generated from any given phase forms the basis of motivation, cognition, metacognition, and behaviour in a subsequent phase.

Use as a key process in CA:SRL

If one of the purposes of CA is to provide information that will help teachers make instructional adjustments, one can consider the validity of CA in terms of whether informed instructional adjustments occur. As the main agents of feedback, teachers promote learning through assessment; however, feedback is not instruction. Some proponents of A*f*L assert that formative assessment definitionally involves an informed instructional response: 'unless some learning action follows from the outcomes, such practice is merely frequent summative assessment' (Black, Harrison, Lee, Marshall, & Wiliam, 2003, p. 2). We do not disagree about the necessity for an instructional response; however, we aver that communication of performance at Stage 4 and the subsequent response to grades or marks on the part of students, parents, and others constitute learning actions. Here we reiterate our position that the dichotomy between A*f*L and summative assessment is a false one in CA. At all junctures between the stages of CA:SRL we include use of information as a key process.

Appropriate use of assessment results may be problematic in CA. For instance, Heritage, Kim, Vendlinski, and Herman (2009) demonstrated that teachers may be able to interpret assessment-based evidence but not similarly able to generate instructional actions in response. If teacher instructional response is an essential mechanism for the effect of A*f*L on learning, we are unaware of evidence that such responses typically occur in ways that are aligned with accurate interpretations of student needs. Students also use assessment information. Even without explicit teacher action or metacognitive prompting, considerable evidence demonstrates that students learn from assessment or the testing effect (Roediger & Karpicke, 2006). The cognitive mechanisms underlying the testing effect may include impacts of repeated exposure on memory, and/or SRL (e.g. learning through iterations of performance and reflection, changes in goal orientation and attributions). Further, the experience of being assessed becomes part of students' knowledge of culture and norms (Gipps, 1999). In addition to demonstrated impacts of assessment on learning and retention, teachers and students act on assessment to make motivational and attitudinal adjustments daily; they learn

each other's expectations and direct their resources accordingly. By emphasizing use in CA:SRL, we suggest that engaging students and teachers in co-regulation of learning can direct the use of assessment towards positive motivation, attitude, and learning gains.

Discussion

We developed the CA:SRL framework for three primary reasons. First, we agree with Bennett (2011) that much research on CA practices lacks backing in a theory of action. This is true despite efforts to recognize that CA is inherently contextual, interactive, enriched by the progression of individual and group learning, and should be conceptually integrated with social-cognitive and constructivist theory (Shepard, 2006). We found that Zimmerman's cyclical 3-phase model of SRL is useful and appropriate as a theoretical foundation for our development of CA:SRL framework, because it regards learning from a social-cognitive perspective learning and highlights iteration and interaction. To further capture the essential interactivity of CA, we took into account concepts of socially shared regulation and co-regulation of learning (Hadwin et al., 2018). We emphasize that the framework represents both students and their teachers as active agents at every stage of the system.

Second, we found that other conceptual work to integrate SRL theory with assessment in classrooms focused entirely on A*f*L, and did not address the blended purposes of CA, which include the evaluative or summative purpose. Formative and summative are terms coined decades ago by Michael Scriven in the field of program evaluation (Scriven, 1967). These terms have pervaded the literature on CA, but in our view, are misnomers, from which the field should move away. They suggest a clear distinction between types of interpretations and uses to which teachers put classroom assessments that is misleading. Cognitively, assessment activities that result in grades and marks are interpreted and reflected upon by students using the same mental processes that self-regulate learning from performance on tasks of lesser consequence. Conversely, from an SRL point of view, to the extent that formative assessment involves a performance phase, it will be followed by a self-evaluation. Whether or not self-evaluation and reflection are guided to focus on improvement is not a characteristic of the assessment purpose but of the way results are communicated and how teachers, students, and others interact in response to the results. Rather than treat the evaluative purpose as inherently inimical to learning, we hope that CA researchers will lend their expertise towards design of coherent and balanced assessment systems intended to narrow rather than widen the gap between learning and evaluative goals (Shepard, Penuel, & Pellegrino, 2018).

Third, we sought to leverage the positive effects on learning of SRL through incorporating it into a systematic approach to assessment, which involves many activities that draw on mental processes similar to those found in SRL. If informed by SRL as a theory for cognitive growth, CA has the potential to impact learning gradually, over time, and cumulatively. In CA, teachers can take advantage of their in-depth knowledge, long-lasting relationships, and frequent interactions with students to help students plan to be assessed, self-monitor as they perform, and reflect and use feedback after assessment to prepare for the next stage of their learning. When teachers support

students' SRL and are attuned to the quality of assessment-based interpretations and decisions, all parties in the classroom can respond to assessment by focusing on educational objectives, setting goals, and acting on feedback with guided effort. Over time, these SRL-guided responses to systematic CA have the potential for high impacts on learning.

CA:SRL contributes to the existing literature in that it draws CA principles and SRL theories together for classroom applications. It embraces the interactivity of students with peers and teachers in monitoring and reflecting upon performance as a shared regulation and co-regulation. Incorporation of the formal assessment purpose of CA lends ecological validity and pushes theory to account for tensions between formative and summative assessment. Potentially, it will seed a new crop of empirical studies to uncover how the full range of CA activities and the theory of SRL can be leveraged together to promote learning and instruction in classrooms.

Disclosure statement

No potential conflict of interest was reported by the authors.

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