

Self-Regulation in the Classroom: A Perspective on Assessment and Intervention

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Il n'y a pas de définition simple et univoque du concept d'apprentissage autorégulé. Des théoriciens de psychologie de l'éducation ont réduit l'éventail des aptitudes des élèves à s'autoréguler en se focalisant sur le versant scolaire de l'éducation, à savoir l'acquisition des connaissances et les objectifs de réussite. Toutefois, le monde complexe de l'étude en classe engendre une situation où différents buts entrent en concurrence aux yeux des élèves. Le modèle d'autorégulation à double processus de Boekaerts montre que les deux objectifs que sont l'étude et le bien-être interagissent. Nous estimons que lorsque les élèves ont accès à des stratégies autonomes bien au point se traduisant par de bonnes habitudes de travail, ils ont une plus grande probabilité de se motiver pour les études et de sauvegarder leur bien-être quand une source de stress bloque l'apprentissage.

There is no simple and straightforward definition of the construct of self-regulated learning. Theorists in educational psychology have narrowed the scope of students' capability to self-regulate through a focus on the academic side of education, namely on learning and achievement goals. However, the messy world of classroom learning creates a situation in which different goals compete for students' attention. Boekaerts' dual processing self-regulation model describes how learning goals interact with well-being goals. We propose that when students have access to well-refined volitional strategies manifested as good work habits, they are more likely to invest effort in learning and get off the well-being track when a stressor blocks learning. Shifting definitions of SRL have led to changing measurement procedures; researchers moved away from decontextualised measures of SRL to domain-specific measures and then on to context-sensitive measures. The validity and reliability of the first generation of SR assessment has been limited and several issues remain. Recently, researchers have designed assessment packages including new instruments that better

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capture self-regulation as a process (including for example traces of mental events, situational manipulations, and records of student work strategies). A combination of instruments is preferable over a single instrument for assessing self-regulation as a process and the effects of interventions to improve students' self-regulatory capacity. At present, many sound SRL interventions exist and some general lessons can be learned about classroom intervention research.

INTRODUCTION

Understanding students' capacity to direct their own learning in school and beyond has been a central topic of discussion among practising educators, policy-makers, and educational researchers alike. Researchers in particular argue that the capacity to self-regulate is central to our assumptions about learning, decision making, problem solving, and resource management in education, and they have promised assessment instruments and intervention programs to promote self-regulation (SR). A basic research question is, "What is implied by the 'capability to self-regulate'?" Some researchers conceptualise SR as a general disposition that students bring into the classroom, whereas others conceive of SR as a property of the person-in-situation and attend to domain-specific self-regulatory skills that develop through experience within and across situations. The two perspectives are not incompatible.

In this article, we first look closely at various conceptualisations of self-regulation that are prominent in the educational psychology research literature and at the types of instruments that have been constructed to measure students' capability to self-regulate. We then discuss intervention programs designed to help students regulate their affect, motivation, cognition, and action in the service of goals. This section also addresses the relative influence of interventions, and identifies some constraints that have limited their effectiveness.

SELF-REGULATED LEARNING: DIRECTING THE LEARNING PROCESS

Over the past two decades, researchers have struggled with the conceptualisation and operationalisation of self-regulatory capacity, coming to the conclusion that there is no simple and straightforward definition of the construct of SR. The system of self-regulation comprises a complex, superordinate set of functions (see Carver & Scheier, 1990) located at the junction of several fields of psychological research, including research on cognition, problem solving, decision making, metacognition, conceptual change, motivation, and volition. Each of these research domains has its own paradigms and traditions. Also, each research community focuses on different content

and aspects of the SR process, addressing different components and levels of the construct. Scanning the most recent literature in educational psychology reveals several evolving models of classroom SR (see e.g. Boekaerts, 1997; Corno, 2001; McCaslin and Hickey, 2001; Pintrich, 2000; Schunk & Zimmerman, 1998; Winne, 1995).

Comparing the major SR models in education, Pintrich (2000) came to the conclusion that each model emphasises slightly different aspects of SR. Corno, for example, emphasises volitional aspects of SR, whereas Winne emphasises the cognitive aspects of SR, and McCaslin and Hickey emphasise the socio-cultural aspects of SR. Nevertheless, all of the models share some basic assumptions. All theorists assume that students who self-regulate their learning are engaged actively and constructively in a process of meaning generation and that they adapt their thoughts, feelings, and actions as needed to affect their learning and motivation. Similarly, models assume that biological, developmental, contextual, and individual difference constraints may all interfere with or support efforts at regulation. Theorists are in agreement that students have the capability to make use of standards to direct their learning, to set their own goals and sub-goals. Finally, all theorists assume that there are no direct linkages between achievement and personal or contextual characteristics; achievement effects are mediated by the self-regulatory activities that students engage to reach learning and performance goals.

For the most part, theorists in educational psychology narrow the scope of students' capability to self-regulate through a focus on the academic side of education, namely on learning and achievement goals. Deliberate restriction of the scope of SR to the construct of "self-regulated learning" (or SRL) highlights both the strengths and weaknesses of the SR models that have been developed in educational psychology. A clear focus on learning goals suggests that the literature on learning processes in various content domains (i.e. how students learn to read, write, and reason about problems) has to be foundational for model development. Equally foundational is the distinction between cognitive and metacognitive functions and subsequent domain-specific extensions of this mode (e.g. Hadwin & Winne, 1998). As Flavell (1979) explained, metacognition (cognition about cognition) refers to two aspects, namely the students' self-awareness of a knowledge base in which information is stored about how, when, and where to use various cognitive strategies and their self-awareness of and access to strategies that direct learning (e.g. monitoring difficulty level, a feeling of knowing).

Limiting the range of goals that students pursue in the context of classrooms to learning and achievement goals has allowed researchers to accrue a detailed understanding of the cognitive and affective processes that underlie actions that students initiate to regulate their motivation and learning in the classroom. By describing the SR strategies that learners use to reach

academic goals, the SRL perspective sheds light on how students form and maintain *learning* intentions but discloses little about students' actions and efforts at regulation when they are not so mindfully engaged in learning. One criticism of SRL models is that the deliberate focus on mindful learning biases knowledge about how students with diverging work habits and regulation styles manage the biological, developmental, contextual, and individual difference constraints that threaten their efforts at SRL. This focus has shed little light on students who do not fit the pattern of a self-regulated learner. Another weakness is that this approach ignores interactions between achievement goals and other goals that students pursue in classrooms such as belonging, social support, safety, entertainment, and self-determination goals (see Boekaerts, 2005).

SELF-REGULATION FOR DIFFERENT PURPOSES

Modern ideas about goal pursuit call into question the notion that there is a direct, uninterrupted path from goal-setting to accomplishing goals. Instead, goal pursuit is viewed as a complex path that sometimes reflects engagement, sometimes disengagement, and sometimes avoidance or delay. The Rubicon model (Gollwitzer, 1990) describes this path as two sides of a river representing commitment. Goal-setting processes precede commitment, referring to when individuals consider "what and why"; that is, they make decisions about objectives, hopes, and where to put their efforts. Students begin to "cross the Rubicon" when they transform their motivation into a firm intention to act. On the other side of the river, goal striving begins. Focus is then on the best way to implement goals; the intention to act is in place, and necessary action plans and scripts are set in motion.

Gollwitzer's work demonstrated that once the Rubicon is crossed, individuals tend not to revert back easily to reconsider goals they have set. As Kuhl (1985) described it, people use processes of action control while they implement intentions, bolstering weak intentions during goal striving (e.g. increasing the value of a task, selectively attending to or encoding information that supports the learning intention, working diligently despite competing action tendencies) (see also Corno, 2001).

Classroom learning is not so linear as this model implies. In school, students pursue multiple goals, not only intending to learn but also seeking positive experiences. Different types of goals interact in complex ways and change over time. Based on studies in mainstream psychology, Boekaerts (1997; Boekaerts & Niemivirta, 2000) proposed a model of SR in which students face two priorities in classroom learning. One priority is to achieve growth goals that increase resources (e.g. students seek to deepen their knowledge or increase their cognitive and social skills); another priority is to maintain emotional well-being within reasonable bounds (i.e. students try

to look smart and protect their ego, or they try to avoid harm and secure resources). Boekaerts hypothesised that students strive to balance these two priorities, straddling the divide between tracks for growth goals and well-being goals. Boekaerts (1999a) found that favorable appraisals of tasks and opportunities for learning (e.g. feelings of relevance, interest, and efficacy) lead students to mastery goals and activities, whereas a sense of difficulty, disinterest, or stress leads students to focus on well-being. Boekaerts' model of classroom SR distinguishes two parallel processes for the purposeful direction of action.

Top-Down Self-Regulation

The mastery/growth process explains the pursuit of self-chosen learning goals or goals that increase academic resources. Mastery strivings are energised from the top down by motivation such as personal interest, values, expected satisfaction, and rewards. The SR is top down also because students' adopted learning goals steer the process. Winne (1995) described the cognitions, feelings, and actions of top-down SR as characteristic of self-regulated learners:

When they begin to study, self-regulated learners set goals for extending knowledge and sustaining motivation. They are aware of what they know, what they believe, and what the differences between these kinds of information imply for approaching tasks. They have a grasp of their motivation, are aware of their affect, and plan how to manage the interplay between these as they engage with the task. They also deliberate about small-grain tactics and overall strategies, selecting some instead of others based on predictions about how each is able to support progress toward chosen goals. (Winne, 1995, p. 173)

Later, Hadwin and Winne (1998) specified the recursively applied forms of metacognitive monitoring and feedback that change information over time (thus influencing goals) as self-regulated learners engage in an assignment. Also, not all students adopt mastery goals when they first tackle tasks. Some students resent teachers' attempts to make them monitor and reflect on their learning, giving preference to established work habits and learning styles that may be maladaptive (Boekaerts & Minnaert, 2003; Corno, 2004). Others seek friendships and harmony with peers—social goals—for example, preferring close collaboration with peers to a work situation in which opinions are criticised and friendships may be compromised. Still others begin work with competitive, performance goals but become oriented toward mastery as they work. Cues from the work environment trigger such evidence of cooperation with others and shifting goals (Volet & Lawrence, 1989; Lawrence & Volet, 1991).

Bottom-Up Self-Regulation

When SR is triggered by cues from the environment it is *bottom up*. Instead of beginning work with goals that are firmly established, it is feedback from the task and classroom reward structures that help to establish work orientations and generate changes in work styles. Boekaerts' model posits that students become concerned with emotional well-being when environmental cues signal that all is not well and that resources have to be redirected. At such a point, students explore the nature of the felt friction. For example, when they feel bored, isolated, coerced, or insecure they may raise the priority of entertainment, belongingness, self-determination, or safety goals, respectively. A search for well-being implies that students are more concerned with maintaining or restoring positive feelings than with the pursuit of growth goals.

While on the well-being track, students might be observed to deliberately withhold effort from the learning task or seem to work playfully with less vigilance. However, bottom-up SR is not maladaptive when it functions to prepare the student for learning. The literature in school psychology describes an array of self-management or coping strategies that students employ to deal with school and home-related stressors, such as achievement-related problems, social needs, being bullied, or coercion. Different types of coping strategies have been observed, including seeking social support and problem solving—viewed as adaptive—which contrast with strategies such as physical and verbal aggression, withholding effort, avoidance, denial, cognitive and behavioral distraction, and rigid or passive behavior viewed as maladaptive (see for example Skinner & Edge, 2002). Note that from the students' point of view all these strategies may be adaptive, provided they successfully restore well-being.

Students who are the focus of school psychology interventions frequently approach classroom tasks with special needs, including specific learning problems (e.g. reading disabilities, language impairment) or characteristics that threaten the pursuit of learning goals (e.g. low motivation, high anxiety, dysfunctional behavior due to poor home conditions, peer pressure, inadequate teaching). It would be incorrect to equate exceptionality with an inability to engage in SR; the students treated by school psychologists self-regulate their cognition, emotions, and actions; often, however, their purpose is to cope with the negative affect they experience in relation to stressors rather than to accomplish learning goals (consequently their SR is often bottom up).

All students face stressors, but by comparison to other students, exceptional students have to manage *chronic* internal and external stressors; they may meet greater obstacles en-route to their learning goals, and as a result experience more negative affect. Frijda and Mesquita (1995) explained that students make a primary appraisal of the situation as relevant or irrelevant

to well-being. Once activated, emotions tend to override goals and actions, even considerations of appropriateness or long-term consequences. These warning signals interrupt ongoing activities, making sure that the event that caused the interruption is evaluated and one's coping potential is considered in relation to the potential threat to well-being.

Using Volitional Strategies to Stay On or Switch Tracks

To provide an adequate explanation of students' SR processes in the classroom, we need to elaborate on the distinction made in the coping literature between strategies that are problem-focused and considered adaptive and those that are overly focused on emotion and considered to be maladaptive (Boekaerts, 1999b). Teachers expect that all goal-directed behavior in the classroom should be guided by the current learning goals. However, as we have said, learning goals are not always adopted by students and sometimes students find it difficult to maintain their intentions to accomplish learning goals even when they are adopted. Following Kuhl (1985), we can distinguish classroom situations in which students are able to make good progress toward their adopted learning goals using top-down SR from those situations in which students face learning goals that are difficult to adopt or accomplish for any number of reasons.

Difficulty of adoption and enactment can occur, for example, when students do not find meaning in the subject matter, or likewise when they confront failure, coercion, or competing goals (e.g. entertainment, belongingness, safety, social support goals). Such obstacles can trigger positive or negative affect that may override any learning goals, causing priorities to shift toward the well-being track. Some students dwell on moods, feelings, and emotions and use maladaptive emotion-focused coping (e.g. self-handicapping, crying, or shouting); whereas others focus on the problem at hand and try to find a solution or use their support network (adaptive, problem-focused coping). We can integrate the learning and coping literature by thinking of problem-focused coping as the application of learned volitional strategies to help protect the intention to learn under conditions of difficulty.

As described by Corno (2001), volitional strategies such as time and resource management, prioritising goals and marking completed tasks are important in school as well as in life beyond. Conditions of difficulty that trigger the need for volitional control may include felt friction due to unrealistic assessments of task conditions, task overload, and inability to mesh academic and non-academic goals.

Boekaerts (2005) and Corno (2004) argue that better evidence is needed of how volitional strategies influence students' abilities to manage their work along the mastery or growth track, and help them orbit back to

productive mastery goals once they have become overly concerned about well-being. Available research does suggest that when students can call upon an understanding of volitional strategies, they can overcome significant obstacles (Kuhl & Kraska, 1989) and maintain a sense of value in the task. Vermeer, Boekaerts, and Seegers (2001) also found that students' willingness to maintain learning intentions and persist toward mastery in the face of difficulty depends on their awareness of and access to volitional strategies (i.e. metacognitive knowledge to interpret strategy failure and knowledge of how to buckle down to work). In a similar vein, Skinner and Edge (2002) concluded their review of the literature on children's coping strategies by noting that the dysfunctional emotion control strategies used by some children reflect a maladaptive coping response to sub-optimal environmental conditions such as models of helplessness or expressions of negative rather than positive emotions by adults, and little environmental support. Instruction in adaptive volitional strategies may be particularly useful for children who need to deal more effectively with chronic stressors in school.

To reiterate, in our view, the Rubicon metaphor must be reconstrued to gain an adequate characterisation of goal-setting and goal striving processes in classrooms. The messy world of classroom learning creates a situation in which dueling goals belie a strict linear transition from motivational to volitional processing with a change that is difficult to undo. Rather, we propose that when students have *access to* well-refined volitional strategies manifested as good work habits, they are more likely to (1) stay on the growth track (i.e. volition strategy use supports top-down SR) and (2) get off the well-being track when a stressor blocks learning (i.e. volition strategy use helps students recover from maladaptive forms of bottom-up SR and supports the environmental cues that lead to adaptive forms of bottom-up SR). Accessible volition strategies function something like the switching track of a railway system; by turning all other lights to red they can keep students on the mastery track *or* re-route them toward goals for productive mastery in the face of detracting environmental cues.

SHIFTING DEFINITIONS OF SRL IMPLY CHANGING MEASUREMENT

In the first part of this article we looked closely at how the SR construct has been conceptualised and reconceptualised by major groups of psychologists who study education. We noted that self-regulation has been defined differently by different research groups. We distinguished SR serving different purposes, namely top-down SR and bottom-up SR, and described volitional strategies as important for persistence and resource management. In this part of our article, we examine the main measurement instruments that are available to assess aspects of SR in classrooms.

Assessments used at particular points in the research history mirror conceptualisations of the SR construct. For example, in the 1970s and 1980s, researchers, following Flavell's (1979) lead, emphasised the metacognitive aspects of SR and appropriate application of cognitive strategies. The focus was on individual student knowledge and skills. Instruments measured developmental qualities such as students' self-awareness of and access to a knowledge base in which information is stored about how, when, and where to use various cognitive strategies. At that time, researchers conceptualised SRL as a relatively stable individual inclination to respond to a range of learning situations in a typical way, independent of the context (be it the classroom, homework, or job training situations). Questionnaires as well as structured interviews (and sometimes teacher ratings) captured regularities in students' reported use of *cognitive strategies* to learn, remember, and understand class material, as well as their *metacognitive strategies* for planning, monitoring, and modifying their cognition. The assumption was that students' self-regulatory capability could be aggregated over or abstracted from self-reported behavior across situations once relevant background factors were partialled out, and that it was valid to assume this capability could be decontextualised in self-reports (e.g. Entwistle, 1988).

As research on SR progressed into the 1990s, existing assessment instruments transformed into domain-specific and situation-specific self-report instruments, and motivation and volitional components were brought to the foreground (e.g. effort management, organisational strategies, persistence at difficult or boring tasks). Examples of domain-specific instruments include the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, Smith, Garcia, & McKeachie, 1993) and the Self-Regulated Learning Interview Schedule (SRLIS; Zimmerman & Martinez-Pons, 1988). The semi-structured SRLIS asks adolescents to describe their study methods to an interviewer who presents them with brief descriptions of hypothetical situations and a series of further prompts. Students are asked, for example, "Do you have specific methods for improving your study at home?" These and similar other self-report instruments are designed to measure the presence or absence and frequency of SRL components in the students' repertoire of responses.

This history reflects a quantitative, dispositional approach to assessment of SRL, which has yielded findings useful for informing theory but created some misconceptions in practice. For example, some researchers using these instruments in field studies informed participating teachers that certain of their students were able to self-regulate their learning while others were not. Teachers were told, on the basis of evidence from the self-report measures, that some students appeared to lack SR capability, and that they relied routinely on external regulation instead. Thus, external regulation has been mistakenly interpreted in opposition to SR, rather than as a continuum of response depending on situations.

Two related shifts in thinking about SRL have furthered our understanding since 2000. First, researchers have come to realise that SRL as it had been operationalised previously by educational psychologists had properties that allowed it to be aggregated over situations and used to predict important outcomes (e.g. that students could be shown to have relatively stable tendencies to use SRL that were systematically related to success in school). At the same time, SRL also appeared in student learning transcripts as a developing process that came into play more or less, depending on the situation. A second important shift was the inclusion of social and emotional factors in SRL models.

A new trend in educational research and in instructional design studies learning as situated and SRL in the pursuit of social-emotional (well-being) as well as academic learning goals (see e.g. Reigeluth, 1999; Stanford Aptitude Seminar, 2002). Education researchers have begun to evaluate students and classrooms experimenting with curricular and teaching reforms following philosophical principles of social constructivism. Several SR theorists declared that co-regulation (i.e. social interactions with teachers and peers) shapes, even develops, the SR process in the service of learning and achievement goals and that, consequently, measurement instruments should capture the quality of social interactions as they evolve in classrooms (e.g. McCaslin & Good, 1996; Patrick, Anderman, Ryan, Edelin, & Midgley, 2001). Newer assessment techniques thus address the quality of students' developing SR skills in so-called "powerful learning environments".

As educational psychologists increasingly shift their attention from investigating SRL as a stable tendency or style, they have begun to study SRL as a developing and dynamic process within classrooms and other contexts where learning takes place. Generalised trait-like measures are still being used in large-scale studies when circumstances preclude more targeted situation-specific assessments; however, researchers no longer find it satisfactory to diagnose students' current repertoire of SRL and then assume that intervention programs should inculcate strategies in the repertoire. Researchers have come to realise that the ultimate goal of comprehensive, insightful models of SRL depends upon study of SR *while it is being generated*.

Several recent investigations (for a review, see Perry, 2002) describe new assessment techniques designed to fit specific contexts and capture students' attempts at SR in action. At the same time, researchers capture student SR "on the fly", they identify features of classroom environments that seem to affect SR both positively and negatively (features such as complexity of tasks, types of instructional techniques, methods of student-teacher interaction, and classroom reward structures). Effects on both the emergence and hindrance of self-regulatory skills have been observed.

From the current research it is gradually becoming clear that students' capacity to interpret environmental cues in light of their multiple goals is

an important aspect of SR. For example, Turner and Patrick (2004), who studied two students' participation in mathematics during two consecutive school years, found that participation behavior was related to teacher expectations, calling patterns, and levels of motivational as well as instructional support. Students' beliefs about their capabilities mediated these results, suggesting that student participation is influenced by teacher practices that both support and undermine the development of good work habits.

The remainder of this section discusses the various instruments that have been developed to measure SR in education.

Instruments that Assess Self-Regulation

Researchers have been creative in designing assessment instruments that portray what self-regulated learners do, think, and feel when they are actively and constructively engaged in learning. These assessments range from strategy self-reports to learning diaries.

Self-report Questionnaires. Most SR questionnaires use reliable Likert-type scales to assess the frequency of students' reported strategy use. For example, the MSLQ (Pintrich et al., 1993), previously mentioned, measures reported cognitive and metacognitive strategy use in close connection to students' motivational beliefs and their techniques for managing resources in a specific domain, such as in an undergraduate college course. This is a quantitative approach to assessment that depends on relatively large numbers of respondents to serve predictive functions, and as we have said, it has created some misconceptions about SRL among practitioners.

Observations of Overt Behavior. Observations capture ongoing rather than recalled actions. Observers decide a priori which categories of SR strategy use and processes they intend to observe (e.g. orientation toward the task, resource management, modifying aspects of the environment, checking progress, persistence following failure) and whether they will focus on individual students or on interactions between students. They also create a sampling plan beforehand (i.e. will there be time sampling or event sampling and for how many sessions), an observation coding system, and scoring procedures (scoring the presence or absence of pre-coded categories of strategies, or codes for narrative protocols or video records). During the observations, typically, coding systems are supplemented by running records of what is going on in the classroom (e.g. the instructional sequence) as well as a (verbatim) record of what the target student(s) and/or teacher said, perhaps on tape. This observation method results in a rich data base of verbal and non-verbal behavior in relation to tasks and social interaction patterns for target subjects. Quantitative results (counts) of responses across categories

can be subjected to statistical analyses, and qualitative methods of discourse and content analysis can be used to describe the data. For example, Turner (1995) observed how first graders used learning and volitional strategies as they learned to read, and related these strategies to the reading instruction and tasks provided. Other research has examined how students co-regulate in cooperative learning groups (see Corno, 2001).

Interview Evidence. Observation studies are often complemented when researchers also use structured or semi-structured interviews (see Perry, 2002; Zimmerman & Martinez-Pons, 1988). The main aim of most *interviews* is to gather qualitative data about students' and teachers' experiences during SRL sessions. *Unstructured* interviews invite students to tell their stories and data are frequently presented as narratives. *Structured* interviews prevent students from jumping from one thought to the other by asking critical questions that build on one another. *Semi-structured* interviews allow researchers to select from the interview sheet those questions that act as context-sensitive prompts, encouraging students to reflect on their strategy use, thoughts, and feelings as well as on their awareness of specific features of the classroom context. *Stimulated recall* is a special form of interview. Students (or teachers, parents, etc.) are interviewed individually while they watch videotaped episodes of themselves working. The aim of these guided recall sessions is to invite respondents to identify and label their own actions during a task (What were you doing (thinking, feeling) here? and to provide additional information about the reasons why). Interview responses can sometimes be quantified (see Xu & Corno, 1998).

Think Aloud Protocols. In a think aloud session, the student reports thoughts, feelings, and SR strategies while solving a problem or completing an assignment. This method produces rich verbalisation data from students. It has the advantage that ongoing thoughts and feelings are registered as they occur, rather than recalled after doing the task. A disadvantage is that students, particularly younger students, may not have a vocabulary that is sufficiently rich to describe their inner thoughts successfully. Also students need a great deal of practice before they can manage the dual task. In addition, the extra task of reporting one's cognitions and feelings can interfere with the target task, thus creating some overload and bias.

Traces of Mental Events and Processes. Another method used to capture specific processes of SR is to examine aspects of student work or work samples. Winne (see e.g. Winne & Perry, 2000) studied the observable *traces of process that students leave behind as they work*, reasoning that as students explore tasks and deal with their content, these traces can be picked up in carefully designed (computer or text) learning studies. Other researchers

collect student work samples, such as text passages marked while studying, sections copied over in a summary, patterns of moves in computer problem solving games, and so on. Student work tells us something about the way the student regulated the learning process, giving evidence, for example, that the student made a distinction between major points in the text and the details. Written comments in the margin of a text are also indicators of ongoing regulation processes, such as “check!”, “need more examples”. Winne linked observed traces to components in his SRL model. For example, the comment “ask Peggy to explain” was linked to the student’s belief that the social context can be used as an effective resource, whereas the comment “see also article Pekrun” was linked to the student’s belief that it is relevant to connect current information with information already stored in memory.

Situational Manipulations. Setting up situational manipulations in true experiments is yet another way to explore SR strategies that students use. Rheinberg, Vollmeyer, and Rollett (2000) constructed a complex computer-simulation system called The Biology Lab. During the learning stage in this system, students detect the system’s structure by freely manipulating input variables and analysing the resulting effects on the output variables. Students can choose how long they work, but they are told that they will have to apply their knowledge in the application stage. Some students use trial and error, others steer and direct their learning by forming and testing hypotheses, making complex comparisons, and still others use a combination of both strategies. The students’ knowledge about the system and the systematicity of their approach is assessed regularly as an indicator of the quality of their learning process. In the application stage of work, students are presented with a specific end state for the output variables and are requested to supply an input state that could lead to the designated end state.

Recording Student Motivation Strategies as They Work. Several instruments have been developed to enable students to share their developing task appraisals and feelings with the researchers as they work. An example is Vermeer, Boekaerts, and Seegers’ (2001) Confidence and Doubt Scale, which registers those aspects of SR concerned with students’ developing confidence in their abilities. Assessments are obtained during the orientation, performance, and verification stages of mathematics problem solving. A beeper sounds at regular intervals, signaling that the students have to register on a five-point scale how confident they feel about their solution at that point.

Keeping Diaries. Students can keep a diary and record their metacognitive or motivation and volition strategies. In Randi and Corno’s (1997) Quest curriculum for addressing SRL in high school humanities, students wrote

entries describing the ways they tried to control their attention, information processing load, and anxiety. Diary entries were analysed like other qualitative data, using coding procedures and thematic grouping. These data are obviously easiest for older students or adults to provide. For example, in a rare study of SR in teachers, Randi (2004) found that pre-service teachers' diaries could be used to provide illuminating examples and narrative accounts, not only of their students' SRL, but also of the ways they themselves self-regulate. Diaries also gave evidence that the pre-service teachers to whom Randi taught the principles of SRL expressed a good intellectual understanding of SRL as a result. Students may open up more in diaries than in some other forms of assessment. One issue with diaries is that some students invariably write more and more openly than others; there is some confounding of comfort with writing and writing ability with SRL diary data.

This overview of assessment instruments illustrates the substantial variability in measurement across extant empirical studies. We move now in the next major section of this article to discuss attempts by researchers to enhance student self-regulation.

SR IN CLASSROOMS: A TYPOLOGY OF INTERVENTIONS

We said in the previous section that models of SR evolved partly because of improvements in the assessment of SR constructs. The same can be said for the evolution of interventions, and enhanced models are influencing interventions as well. There is no shortage of intervention in education, but documenting intervention effects has been difficult. In part this is attributable to the complex system in which classroom interventions are embedded. Only since the early 1980s have researchers analysed classroom data using hierarchical modeling procedures to separate the nested effects of interventions on students within classrooms, within grades, within schools, and within districts (Cronbach & Webb, 1982). Classroom interventions are also (and should be) subject to unique adaptations by individual teachers according to the exigencies of their own curricula, values, and beliefs (Randi & Corno, 1997). The best evidence on social programs suggests that educational interventions are almost always realised differently from the ideals held by researchers and program designers; in addition, educational evaluations are political as well as scientific undertakings.

Our discussion addresses the variety of constraints on scientific work in education that limit the effectiveness of early efforts to evaluate SR interventions in classrooms (see Corno, 1995). Many of the issues and constraints we identify are present in research on educational interventions of all types, and some have a long history (Campbell & Stanley, 1963). The difficulties that remain challenge the latest generation of intervention

research, continuing to restrict the widespread adoption of SR programs. Because space limits preclude extensive analysis, we present a typology of SR interventions that spans recent decades. Our typology includes examples of both strong and promising programs classified within three broad categories. The first category represents *cognitive-behavior modification programs*, the purpose of which is to retrain or replace certain maladaptive cognitions and behavior with more adaptive ones. The second category of programs *directly teach or aim to develop the skills and strategies* that underlie SRL in classrooms. And the third category describes a new generation of programs that make changes in the classroom milieu supporting student SRL as it develops. Student–student interactions in subject-specific contexts and activities are central sites for interventions of this last type. This new generation of programs evolved from specific developments in *sociocultural theory*. Together the three categories cover the range of efforts by educators to address SR—namely, programs that suppress unproductive or maladaptive thinking and behavior, programs that promote new SR skills and strategies, and programs that encourage and support SR as it develops in situ.

Cognitive-Behavior Modification Interventions

The earliest interventions in SR grew out of school psychology and behavioral approaches to self-management, ultimately reflecting the move from behavior to cognition. Early programs targeted students with emotional and behavioral disabilities who required special attention to perform successfully in regular classrooms. Diagnosed needs became part of an individualised educational plan that addressed change using various behavior modification procedures. Three types of interventions designed for classroom use serve as examples.

Stress Inoculation Therapy. Meichenbaum (1977) described cognitive-behavioral procedures to help students on the well-being pathway with concentration and emotion control problems. Specifically, this intervention focused on ways to direct and maintain attention, modulate emotional arousal or evaluation anxiety, and cope with difficulty. Students were, for example, taught to replace physiological experiences of anxiety and distorted perceptions with targeted questions that help them prepare to learn. Meichenbaum’s research demonstrated that students can be effectively taught to replace maladaptive thoughts such as “I can’t do this problem” with productive self-questioning, such as “In what different ways can I do this?” Stress inoculation based on cognitive-behavioral procedures can be costly if several training sessions are necessary to establish a pattern of self-monitoring in students. In addition, behavior reporting can be time-consuming and cumbersome when used in regular classrooms. The extrinsic

reward option in these programs remains controversial, and some teachers are uncomfortable offering them. Furthermore, the multiple procedures involved in these interventions make it difficult for researchers to establish which components of a given multi-faceted intervention are necessary for success; it could be the entire combination or only one procedure that is causative.

Mental Simulations. To overcome some of these problems, researchers designed programs that trained students to use specific strategies and subsequently apply them in simulated situations. Taylor and Schneider (1989) zeroed in on a simple cognitive exercise they hoped would accomplish several coping objectives at once. In their “process simulation” intervention technique, the teacher gets students who have trouble focusing to imagine a scenario in which they successfully accomplish a goal just before actually tackling a task (e.g. to study for an exam and get a good grade; to complete homework, etc.). Students “run” a complete simulation of themselves accomplishing the task—being clear in their own mind about where, when, and what they are doing—at a regular time of day during each of 5–7 days prior to beginning work toward the goal. The mental simulation involves planning and setting expectations at the same time that it encourages self-awareness about outcomes, thus helping students to alter dysfunctional beliefs that may be distorting experiences. Experiments with college students show the use of process simulations to be an effective way to control focus on the work to be done. In addition, students will extend the procedure to new situations on their own (see Taylor & Pham, 1996).

Manipulating Students’ Motivation in Tasks. A growing number of educational psychologists studied ways to influence aspects of motivation in younger students (such as goal-setting, efficacy beliefs, attributions) in school subject-matter tasks. With few exceptions, motivation process interventions ask students to work individually or in small groups with a remedial teacher or school counselor on tasks designed to manipulate the target process. Some researchers target processes in three phases of SR—preparation, during tasks, and following task completion (self-evaluation).

Perhaps most notable are the series of experiments by Schunk and colleagues (see Schunk & Ertmer, 2000, for a review), work by Zimmerman (e.g. Zimmerman & Ringle, 1981), and the attribution retraining procedures of Dweck (1991). For example, Schunk asked students assigned at random to complete a set of math problems under different conditions—one group worked under instructions to set specific and proximal sub-goals (to complete a number of items within a time limit); another group set rather general goals (to complete the entire problem set). In some studies, the experimental group also checked answers as they worked, and used given

information that successes are due to effort and taking the right approach; control students were told their success depends on ability or chance. Many studies have a modeling component—a peer or teacher models the strategies to use. Results show that efficacy and performance on tasks are favorably influenced when students set specific goals, effectively use feedback, and make appropriate strategy attributions (see Pintrich, 2003). Researchers then recommend that teachers should attend to goal-setting, feedback use, and attributional responses as part of their regular classroom instruction, and some investigators have developed classroom programs for this purpose (Schunk & Zimmerman, 1998).

Unfortunately, when researchers make suggestions to teachers about ways to change their instruction, they invite a range of possible responses that do not necessarily ensure that teachers attend to diverse student needs in a context-sensitive way. In addition, theoretical models increasingly suggest that motivation must be addressed at the classroom (rather than the individual student) level. This shift in theorising has led to another type of intervention aimed at the well-being pathway of SR. The intervention can be seen as providing a means for teachers to actively suppress or reorient maladaptive behavior and motivation patterns for an entire class, rather than addressing the needs of students on an individual basis in pull-out sessions. The ultimate objective, however, is the same—to encourage individual students toward productive self-management.

Modifying the Classroom Environment. Ames (1992) described inconsistencies between SR theory's emphasis on active student engagement, i.e. goal-setting, self-monitoring, and self-evaluation, and the performance evaluation systems extant in traditional classrooms. When students work to obtain good grades and other external rewards, compliance rather than independence is both the message given and the result (McCaslin & Good, 1992). Accordingly a program targeting the classroom environment for change aims to remake the whole "system" by which students are evaluated and in doing so, gives new meaning to the term "classroom management".

One example is the TARGET program that Ames (1990) adapted for classroom use. The acronym, TARGET, refers to six aspects of classroom structure that teachers can modify to promote motivation to learn in students (the mastery path) rather than motivation to hide weaknesses or outperform others (the well-being path)—namely, Types of tasks, lines of Authority, means of Recognition, Grouping methods, Evaluation practices, and use of Time. Ames' (1990) recommended changes to each aspect are derived from a variety of studies and from goal theory. The intervention is consistent with top-down SR in that it encourages students to set their own learning goals and then work toward mastery, rather than focusing to

complete tasks prescribed by others (volition-driven SR), or being overly focused on safety and security (bottom-up SR).

Just as with any framework that allows teachers latitude in implementation, there are a number of ways teachers can make changes reflecting the TARGET system, and so it has been difficult to evaluate the full program systematically. Nevertheless, Ames (1992) reported that teachers who move their classrooms in the TARGET direction have increasing numbers of students who show evidence of motivation to learn (see also Patrick et al., 2001). Interventions like TARGET get closer to the ultimate goal of developing all students' SR capabilities, but still do not go far enough. The need remains to clarify influences on the cognitive learning/mastery track of SR models, and that is the direction of the second broad class of interventions in our typology.

Direct Instruction in Learning and Metacognitive Skills and Strategies

This class of interventions focuses on cognitive and metacognitive aspects of SRL that are particularly critical for students with learning difficulties, and on the learning-to-learn and study skills of students in regular classrooms. The underlying premise derives from the previously described research linking cognitive components of SR to achievement outcomes.

Academic Strategy Instruction. Early strategy instruction programs targeted students needing academic remediation, and delivered lessons as mini-courses offered by researchers or special instructors. For example, Weinstein (see e.g. Weinstein & Mayer, 1986) developed a general study and learning skills program for college students and a Learning and Study Strategies Inventory to provide them with feedback before and after the course. Other self-report scales such as the MSLQ described previously have also been used to diagnose improved understanding of strategies taught in such programs. Path analyses conducted by researchers on data from studies of separate courses such as Weinstein's as well as from courses modified to include strategy instruction in subject areas such as science or humanities confirmed the influence of improved strategy use on subsequent achievement such as course grades.

Following the move to develop curriculum standards for subjects taught in kindergarten through secondary school, researchers also modified textbooks and other curricular materials. They moved beyond decontextualised strategy instruction to emphasise use of strategies in context, transfer of use to new contexts, and metacognitive reflection. For example, Pressley and his colleagues (Pressley, Woloshyn, Lysynchuk, Martin, Wood, & Willougyby,

1990) developed the “good strategy user model” and trained classroom teachers to use it. Teachers receive training in how to instruct students in memory support strategies, ways to monitor their reading comprehension in text learning, and in how to evaluate what they have learned. Many such strategies are now integral to teacher education in subjects ranging from literacy to mathematics. Evaluations of research on the teaching of metacognitive skills and strategies show that good strategy users read more fluently and with better comprehension than students receiving more traditional literacy instruction, and there have been similar results with problem solving in mathematics (see e.g. Pressley, 1986).

Following innovations in models of instructional design, other researchers embedded worked examples of SR strategies in subject-matter textbooks and homework assignments. To the extent that strategy instruction has become a regular part of many school-adopted textbooks series, these are important successes for SR intervention research. However, following a traditional paradigm of instructional design raises other issues because it tends to focus on individual students rather than the larger sociocultural context in which students work and to over-engineer the instruction, sometimes to the point of scripting teachers (see Reigeluth, 1999). This observation brings us to the third broad category of SR intervention in education.

Second Generation Classroom Interventions based on Principles of Socioculturalism

Through the 1990s, as subject-matter research in education increased understanding of the disciplinary practices underlying domain expertise, it became clear that expertise in subject areas is enhanced by skillful SR. Accordingly, there have been developments that include SR instruction in the design of subject-specific interventions focused on outcomes such as reading comprehension, composition, problem solving in mathematics, and inquiry in science (Alexander, 1997). These interventions are based upon explicit assessment of relationships between the processes needed to do meaningful work leading to expertise in each subject area and corresponding components of SR. Increasingly, researchers also have learned how important it is to work closely with classroom teachers to develop instructional programs for use as a regular part of activities commonly found in elementary through secondary classroom curricula.

Classroom teachers can make the best of an intervention or compromise it. Their on-job expertise is at a different level than what comes to them in education courses, and through it they learn to innovate (Randi & Corno, 1997). Researchers concerned with treatment fidelity rarely welcome teacher innovation. And yet, paradoxically, “pedagogical knowledge of subject matter”, i.e. knowledge of how to teach complex ideas to particular students, is

now recognised as critically important to effective education interventions. Every teaching act is situated in a particular context, affecting to some extent what is taught.

Each of these realisations is consistent with the premises of modern socioculturism, a theoretic framework that explains the dynamics through which human culture shapes human development (Vygotsky, 1978). Recently, there has been an infusion into SRL interventions of sociocultural objectives and features, including, for example, the appropriation by students of domain knowledge and SR skills through cognitive apprenticeships in classroom activities, use of new technological tools for mediated learning, and learner-to-learner collaboration within communities. In short, like the assessment procedures we described previously, the most recent interventions appear quite different from those implemented just two decades before.

Apprenticeships in Activities that Develop Subject-matter Expertise. According to Collins, Brown, and Newman (1989), subject-matter expertise comes about naturally when teachers apprentice students to the interworkings of a discipline. When students learn from teachers how to think about academic work, to reason through problems, to question assertions and present arguments, and to use cognitive activities such as study tactics, they begin to think more like experts than novices. As teachers model and explain their thinking in the variety of tasks and activities they expect students to perform, the process of doing the intellectual work is demystified and students can eventually take over.

Palincsar and Brown (1984) developed a cognitive apprenticeship procedure called “reciprocal teaching” to improve the reading comprehension of regular classroom students. In reciprocal teaching, students observe their teacher who thinks out loud while reading text, and then asks students to do the same. As she reads, the teacher models comprehension monitoring and memory support strategies such as summarising, rereading, marking important points, and asking “Wh” questions (as a teacher would). Students take over the process in the same way and also critique one another’s questions. This pioneering model of apprenticeship has been incorporated into other successful programs in different subject areas, including writing and composition (Bereiter & Scardamalia, 1982; Harris & Graham, 1996), and science and mathematics (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991; White & Frederiksen, 1998). These programs offer strategy apprentice work between peers as well as between teachers and students as a central aspect of subject-matter lessons and related activities. Again results show positive effects on strategy acquisition and other targeted cognitions, oftentimes leading to improved achievement outcomes.

Unlike the earliest academic strategy instruction programs, peer apprenticeships depart from the traditional classroom arrangement in which the

teacher retains instructional authority, transmitting cognitive and metacognitive knowledge and skills along with subject-matter lessons. Nowadays as well, increasing numbers of classroom teachers rely on technological innovations to assist in efficiently inculcating learning and problem solving skills in the context of knowledge-based, dynamic instructional environments. If students are to be truly “self”-regulated, then instruction should build upon all available resources in the instructional environment, including peers and tools, to activate SRL efforts, *mediating* rather than short-circuiting or supplanting students’ own learning (Salomon, 1983). Teams of researchers are designing innovative applications of technology tools for widespread adoption in regular classrooms, capitalising on developments in computer learning environments such as hypertext and the Internet. In addition, researchers now target the larger systems or contexts in which SR capability can be learned (e.g. teachers’ SR, homework, and virtual school or distance-based reforms), rather than just the classroom learning of individual students.

Computer Mediated Learning Environments. Computers are arguably the contemporary vehicle for mediated learning, offering new opportunities for assessments embedded in instructional activities and events. Originally defined by Feuerstein (1979) in reference to student and tutor transactions, mediated learning now refers to adaptive instruction that can be provided by intelligent computer software. The software supports learning through hints and feedback, opportunities for reflection, and links to other sources of information. As more teachers use interactive computer programs for classroom applications, researchers are examining student responses and strategies, patterns of use, and effects on related outcomes. They are also studying how student response models and patterns of help seeking may be used to tailor feedback and continued instruction as well as further program development (see Alevén, Stahl, Schworm, Fischer, & Wallace, 2003).

An array of interactive software programs are being tested and many already demonstrate promising results; the much-touted possibilities for technology in education may actually be realised (e.g. our previous reference to Rheinberg et al.’s Biology Lab). A central instructional principle of the most sophisticated computer mediated environments is the notion of “scaffolding” for student SR (Bruner, 1975). That is, the programs are designed to provide sufficient help and support for beginners to ensure gains on initial assignments and activities along with the bells and whistles that innovative programs provide. Early successes build expectations for further success. Once students start to demonstrate criterion levels of response, the program then removes pieces of scaffold little by little, ultimately pushing students to “solo”. Students actually develop and refine their own SR routines in the context of whatever knowledge environment they experience.

Examples of interactive software programs with embedded instruction in SR include the videodisc-based mathematics problem solving series featuring “anchored” instruction called Jasper (Cognition and Technology Group at Vanderbilt, 1992); programs for self-regulated studying that can be customised for different subject areas (Hadwin & Winne, 1998; Winne, Hadwin, Beaudoin, & Murphy, 2003); knowledge integration environments that include “computer partners” (Linn, 1995); and the scientific “explanation constructor” (Sandoval, 2003). Among these example programs only the Jasper series has gone beyond early stages of R&D. Evaluations of Jasper show effects on problem solving scores in the expected directions when teachers use the program consistent with developers’ recommendations (Hickey, Moore, & Pellegrino, 2003).

Interactive programs supplement the teacher’s repertoire for building SRL capacity in students while they acquire domain knowledge, providing a way for teachers to leverage time and expertise with a reliable and engaging instructional product. However, because not all teachers have access to such programs, teacher expertise can also be leveraged through new varieties of group learning.

Collaborative Learning in Classrooms. Beginning in the late 1970s, research by Webb (1980) on group processes in classrooms and their effects began to put substance in what had been an evidential vacuum. Webb (1991) discovered, for example, that students tended to help one another when they worked together on small group activities; intellectually able students deepened their learning by explaining concepts to peers in need of support, redefining what is meant by SRL. Lower achieving students benefited from the (typically effective) explanations provided by able peers, as well as from students who modeled good work habits. Early findings such as these have been enhanced by a next generation of theory-driven research on cooperative learning, and many classroom interventions now exist for learning that is collaborative (see Webb & Palincsar, 1996, for a review). The general understanding is that collaborative learning supports *self*-regulation because peers model and discuss their own learning and motivation strategies, which are then “distributed” across the group for individuals to pick up and modify to suit their own needs.

Brown and Campione (1994) carried out a number of classroom interventions in ecological science using a form of cooperative learning in which each student completes a portion of a group project doing research which the group discusses collectively and presents as a team. These researchers used collaborative “Jigsaw” groups as a key part of an overall approach to having students learn a few “big ideas” about the subject deeply, enhancing understanding of connections to related subjects. The concept of a meaning-based “classroom learning community” developed by Brown and Campione

has been adapted for use in other content domains. Researchers now refer to “powerful learning environments”, which frequently include computer mediated programs as enhancements as well as discussion-based approaches to eliciting student learning (see DeCorte, 2004, for discussion of several examples of powerful learning environments).

Current Developments: Learning Communities in Schools and Beyond

We would be remiss not to mention some innovative efforts at the forefront of the current education horizon that move beyond the scope and categories defined for classroom research. These are comprehensive interventions aimed at reforming entire schools and sometimes the systems in which they are embedded. Taking to heart notions of social constructivism—such as that meaning comes about from social interchange—these interventions seek to establish a wider learning community beyond individual classrooms in which teachers as well as students are learners. There is an assumption of continuing cycles for study and practice bolstered by necessary resources and support at the highest levels of the school system. Efforts by individual teachers to engender SR in students will have greater cumulative effects, presumably, if they are supported by the larger school context. We discuss examples of these innovations to make some final summary points about the current status of intervention research.

Establishing and Evaluating School-wide Interventions. One school-wide SR reform is the Interactive Learning Group System (ILGS) innovation program in the Netherlands (Boekaerts, 1997; Boekaerts & Minnaert, 2003). The project, targeting vocational secondary schools, has been evaluated at several system levels for effects on both teachers and students in the short and long terms (see Boekaerts & Minnaert, 2003). The ILGS follows from instructional principles for the design of powerful learning environments to promote SRL (Design-Based Research Collective, 2003). In one study, teachers were trained to decrease knowledge transmission to a quarter of a lesson unit; to develop assignments for small groups formed on the basis of student learning styles; to help students activate relevant prior knowledge; and to increase their coaching of skills. Although there were many successes in this project, evaluations reinforced the political nature of a comprehensive school-wide innovation, raising several implementation issues and concerns, some of which we have already noted. For example, one finding from this study that commonly occurs in school-based intervention research is that teachers in the non-intervention groups were influenced by the new ideas being taught to intervention teachers; the intervention’s appeal led them to adopt some of the principles targeted by the new instructional

model. This sort of confounding compromises the internal validity of the treatment, but recommendations to keep control group teachers blind to treatment distinctions are impractical. That this is a seemingly intractable problem in educational research is an important testimony to the credibility of sociocultural assumptions (see Cook, 2002).

One insight from this project is that the innovation gave educators a good grasp of the processes that underlie students' choice of processing modes and regulation strategies. By providing this deeper understanding to teachers, the program equipped them to observe the changing psychological needs of students and use them to adapt instructional strategies. This finding suggests new ways of investigating the role of student individual differences during adaptive instruction (Stanford Aptitude Seminar, 2002).

We said previously that teacher innovation is an important step towards increased external validity in the delivery of treatments. However, to secure internal validity for successful evaluation, researchers have to convince educators to navigate through the cyclical innovation process, deciding when to make changes and when to stabilise the innovative instruction so that it may be evaluated empirically. Boekaerts and Minnaert suggest there is a difference between school improvement efforts designed to help school personnel implement their own reform strategies, and research-based interventions seeking to assess the validity of a treatment (see Pintrich, 2003, for a similar position). It may be that the latter are best conducted in laboratory schools where the innovative programs can be tested under optimal conditions.

Teachers as Partners in Research. Another school-wide reform effort to which we have referred is Perry's program in Canada. Perry and her colleagues used descriptive research on teaching writing to young students to develop new assessments of SRL. Their early studies add support to the TARGET framework described previously; classroom tasks, authority structures, and evaluation practices shape young children's approaches to learning and those approaches vary in academic effectiveness.

In recent work, Perry and colleagues addressed the possibilities that come forth when teachers work with researchers to design tasks and interact with students in ways that promote independent, academically effective SRL. Perry, Phillips, and Dowler (2004) demonstrated how teachers who are masters at creating high-SRL environments can mentor new teachers. This includes, for example, co-designing tasks and practices that foster elementary school students' SRL in a learning community using procedures such as "data-directed dialogue" (Strahan, 2003, p. 127), where teachers converse about student responses to various assessments.

Sociocultural theory supports the observation that teachers themselves need a firm intellectual understanding of the SR construct to encourage SR

in students. Accordingly, Randi (2004) gave preservice teachers opportunities to develop SR in partnership with researchers who help them move to the “other side of the desk”. Randi’s intervention distinguished student work styles and study habits from volitional strategies teachers engage to learn from their teaching. Her work illustrates the value of preservice teachers’ own volitional strategy use for their purposes, reifying volitional constructs as they are embodied in teaching practice. Teacher preparation programs might profitably structure learning environments affording teachers opportunities to learn SR and then apply the strategies to their own teaching. Presumably, once a firm grasp of SR is in hand, teachers exiting their preservice courses will be more inclined to address the construct in their own classrooms, thus launching the knowledge base beyond the university.

DISCUSSION

In the first part of this article, we defined SR and described its two parallel tracks in classroom learning. We considered how students who are faced with chronic stressors such as learning and emotional disabilities use SR processes primarily for maintaining and restoring well-being. We said that effective coping and self-management can be brought about through sound intervention focused on volitional strategy use by students who need help, and this can make an important difference in their struggles to adjust to school. Self-regulated *learning*, in contrast, develops through purposive engagement with the fundamental concepts and structure of subject matter as students wrestle with complex and challenging tasks along the mastery pathway.

We provided a historical tour of the assessment procedures used in educational psychology to measure various aspects of SR. We demonstrated how shifting definitions of SRL have led to changing measurement procedures; researchers moved away from decontextualised measures of SRL to domain-specific measures and then on to context-sensitive measures. Also we illustrated how researchers have made use of different types of assessment tools that, together, reflect our present understanding of what SRL is and which factors affect it favorably and unfavorably.

The validity and reliability of the first generation of SR assessment has been limited and several issues remain. One issue is that much research registers only the presence, absence, and frequency of specific components of the SR process. Although there has been sufficient research to address systematic errors, and the instruments used are easy to administer, in self-report questionnaires such as the MSLQ, social desirability and response bias are difficult to eliminate. Validity remains an issue with all forms of self-report because student recall can be inaccurate; systematic error may result when students consistently under- or overestimate their strategy use.

Another concern is that because early self-report instruments were constructed on the basis of data from successful students, the resulting scales are not always valid for less successful students. In fact, data collected with some of these instruments has led practitioners to misinterpret low scores on subscales as indicating a “lack of SR”.

Our discussion addressed a second essential purpose of assessment: to establish effects of intervention programs. No matter what instruments are selected from the available array, investigators often realise that a combination of procedures is needed to measure SRL in any given learning context. For this reason, researchers have designed assessment packages including new instruments that better capture the specific outcomes of an intervention (including for example traces of mental events, situational manipulations, and records of student work strategies). In theory, groupings of appropriate assessment tools can capture true or systematic variation (and change) with greater breadth and precision than can any one instrument. A disadvantage of new instruments is that more research is needed to determine associated systematic error. The present state of art clearly dictates, however, that a combination of instruments is preferable over a single instrument for assessing the effects of given interventions. If researchers examine students' self-regulatory capability from different vantage points using different methods of assessment (triangulation), and the results appear similar, then they can be reasonably certain that major aspects of reliability and validity have been achieved.

In the intervention section of this article we described a typology of SR interventions that spans recent decades. We discussed early attempts to improve students' SR skills that took either of two forms: encouraging individual students toward productive self-management or directly teaching the (meta)cognitive skills and learning strategies that successful students already used. Second generation classroom interventions went beyond traditional classroom arrangements to target students' learning strategies and metacognitive skills as well as the importance of adopting the broader goal of becoming a responsible and independent learner. A conceptual model of the self-regulatory skills and volitional strategies that students should be able to use in various content domains guided these next generation innovations.

We referenced many of the sound SRL interventions extant, and reviewed some general lessons learned about classroom intervention research. The most persistent issues that plague educational intervention research in general and SR interventions in particular revolve around the relatively greater attention researchers have paid historically to internal versus external validity (Cook, 2002; Cronbach & Snow, 1981). Educational researchers want to draw firm conclusions about effects of their interventions on targeted classrooms and on individual students' developing capabilities to self-regulate. At the same time, they want to be able to apply their findings to

different settings with similar results. If faced with a choice between external and internal validity, many educational psychologists engaged in school improvement give priority to external validity. They reason that educational research should be classroom-based and classroom-targeted, contending that the costs of being wrong about the causal inferences are not very high since classroom-based investigations can be cross-fertilised by research in laboratory settings.

Directions for Future Research on Self-Regulation in the Classroom

To address some of the shortcomings of past and present research outlined above, we conclude this article with a short list of six guidelines for future research on SR assessment and educational intervention. First, our review suggests that SR research in education should be guided by a clear conceptual model that describes the roles and functions of top-down and bottom-up SR in the classroom acquisition of subject-matter knowledge and skills. The basic tenets of this conceptual model should be specified in terms of several propositions (direct and indirect relations, moderators and mediators, as well as boundary conditions). Second, specificity and reciprocity in relations among different types of learning environments in and outside classrooms, particular moderators and mediators, and associated outcomes should be formulated and tested. Third, as more assessment tools provide embedded instruction in SR strategies, outcome measures should extend beyond standardised indicators of academic achievement to examine improvement on other indicators such as work samples and attainments (academic accomplishments such as awards in math clubs or science awards) over time. The target should be assessing how students generate SR strategies at the point of use, and adapt them flexibly in pursuit of their goals and in response to environmental cues that might lead to changes in goals.

Research on SR in classrooms needs to disentangle the SR processes that students use to manage learning situations that are intellectually complex and challenging from the SR processes that students use to deal with environmental cues that trigger emotions and a shift in goals. We need to catalogue the various strategies that students use to deal with biological, environmental, developmental, and individual difference constraints and examine systematically how bottom-up SR interacts with the top-down SR and volitional strategies that have been more common objects of classroom studies.

Fourth, researchers should be more willing to discuss their conceptual models, assessment tools, and research designs among themselves, collaborating on how best to develop aptitudes for academic work. They should continue to dispute the nature of the evidence supporting the effectiveness of old and

new comprehensive intervention or treatment packages. Several researchers argued that there is a need to unpack individual components of these packages to establish their connections to corresponding components of SR and more distal outcomes.

Fifth, researchers should attend closely to how SR interventions are experienced by teachers as well as students, and work with teachers to alter those aspects of their teaching with which they feel comfortable—perhaps in lieu of revolutionary and cross-cutting change. Perhaps then the real world of the classroom will provide a more convivial home for SR interventions. Our final suggestion is that researchers also examine the socio-political dimensions of the construct; that is to say, they should study its semiotics and what it means to establish a goal for all students to become self-regulated learners (see McCaslin & Good, 1996, for a beginning).

Our analysis suggests that at its best, classroom education *can* lead students toward the adaptive use of top-down and bottom-up SR in conjunction with volitional strategies because teachers and others in the extended social milieu provide models, serve as coaches, and establish environments conducive to SR. However, there will remain constraints in classroom and related environments that interfere with student efforts at SR. These include conflicting goals, unproductive work habits and styles, and inappropriate teaching methods, all factors that will continue to compromise the goal of increasing SR capabilities for large numbers of students, no matter how carefully designed the research.

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