Fusing Self-Regulated Learning and Formative Assessment: A Roadmap of Where we Are, How we Got Here, and Where we are Going

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Abstract

We have long known that a relationship exists between how learning is assessed and the learning processes and strategies students employ when engaged in those assessments. Black and Wiliam pointed out in 1998 that self-regulated learning should be a primary goal of formative assessment. Since then, a growing body of research on this relationship has been produced. The purpose of this paper is to present and discuss keystone publications that inform our current understandings of the relationship between formative assessment and self-regulated learning. The result is a map of the development of the field and directions for future research.

Keywords: self-regulated learning, co-regulated learning, classroom assessment, formative assessment, assessment for learning, self-assessment.

The fusion of two of the pillars of educational research— educational assessment and self-regulated learning (SRL)—is an exciting and generative development. In this article, we present a historical trajectory of the most relevant theoretical and empirical reviews that have explored the connection. Our aims are to illustrate current understandings of the relationship between assessment and SRL, providing a roadmap of how we got here, and providing a signpost for moving the field forward.

The first pillar, educational assessment, is one of the oldest fields in educational research (Brookhart et al., 2016). Traditionally focused on psychometrics, it underwent a shift two decades ago with the emergence of the formative assessment (FA) movement (Wiliam, 2011). FA is classroom assessment that provides information to teachers and students about students' progress, and then feeds forward to support adjustments and revisions to both teaching and learning, resulting in improvements (Black & Wiliam, 1998; CCSSO, 2012).

The second pillar, self-regulated learning, is the study of how and when learners set goals and then systematically carry out cognitive, affective, and behavioral practices and procedures that move them closer to those goals (Zimmerman & Schunk, 2011). Scholarship on self-regulation organizes cognitive, metacognitive, and motivational aspects into a general view of how learners understand and then pursue learning goals. One outcome of the FA movement (which has also been called assessment for learning) has been to establish links between the two pillars. Over the past two decades, scholars have recognized the similarities between FA and SRL in terms of their respective forms and functions, and explored the reciprocal support they can provide, under the right conditions. In the next sections we define each construct and explain the relationship between them.

Formative Assessment

Differences in the ways that formative assessment is defined by different authors (e.g. Bennett, 2011; Pryor & Crossouard, 2008) are meaningful when articulating research

questions or designing classroom practices. For the purposes of this paper, however, a broad stroke definition that focuses on the ultimate goal of FA—to help students to learn and teachers to teach (Wiliam, 2011)—is most appropriate. We use a widely cited definition:

> Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited (Black & Wiliam, 2009 p. 9).

Because formative assessment provides feedback to students that they can use during learning to monitor and regulate that learning, scholarship on the relationship between assessment and SRL has an almost exclusively formative orientation.

There is broad and growing agreement that formative assessment has the potential to inform much-needed changes in both instruction and assessment in schools (Andrade & Cizek, 2010). One of the main reasons this is the case is that formative assessment accords with modern learning theories that acknowledge students' central role in constructing their own learning (Penuel & Shepard, 2016). Formative assessment, done well, assists students to conceptualize what it is they are trying to learn, how they will know they are learning, and how they will move forward with next steps. These processes activate students' cognitive and motivational capacities, focus students on their learning goals, and provide feedback and strategies they can use to help them reach their goals. In short, assessment can help students self-regulate their learning.

Self-Regulated Learning

SRL refers to "self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals" (Zimmerman, 2000 p. 14). Phase views of SRL allow theorists to place cognitive, metacognitive, and motivational constructs into the

sequence of events that occur and recur as students self-regulate. Current models of SRL have three types of phases in common (Panadero, 2017; Puustinen & Pulkkinen, 2001): (1) a preparatory phase that includes task analysis, planning, and goal setting; (2) a performance phase that involves the use of learning strategies and monitoring activities such as comprehension monitoring; and (3) an appraisal phrase, which involves reflection on and evaluation of learning outcomes.

Several decades of research, as well as recent meta-analyses and reviews, have demonstrated the link between SRL, the use of learning strategies, and academic achievement (Panadero, 2017; Richardson, Abraham & Bond, 2012). Fortunately, SRL can be developed through a variety of instructional interventions that provide students with support and guidance in the use of learning strategies. Studies of a variety of instructional interventions have produced evidence of its influence on student success (e.g. Dignath & Büttner, 2008). Few such studies, however, have focused on the role of assessment in promoting SRL: Examinations of that particular relationship tend to be limited to the field of formative assessment.

Relationship between SRL and Formative Assessment

Research and theory on assessment emphasize regulatory goals and processes that also characterize SRL (Andrade & Brookhart, 2016). Take, for example, the description of formative assessment formulated by the Council of Chief State School Officers' (CCSSO) Formative Assessment for Students and Teachers (FAST) State Collaborative on Assessment and Student Standards (SCASS) (2012):

> Formative assessment is a process used by teachers and students during instruction that provides feedback to adjust ongoing teaching and learning to improve students' achievements of intended instructional outcomes. The attributes below have been identified as critical features of effective formative assessment:
>
> • Learning Progressions. Learning progressions should clearly articulate the sub-goals of the ultimate learning goal

• Learning Goals and Criteria for Success. Learning goals and criteria for success should be clearly identified and communicated to students

• Evidence of Learning. Evidence of learning is elicited during instruction

• Descriptive Feedback. Students should be provided with evidence-based feedback that is linked to the intended instructional outcomes and criteria for success

• Self- and Peer Assessment. Both self- and peer assessment are important for providing students an opportunity to think metacognitively about their learning

• Collaboration. A classroom culture in which teachers and students are partners in learning should be established.

Note especially the reference to the role of assessment practices in monitoring student learning. Effective formative assessment is used by teachers and students to articulate the learning targets (preparatory phase goal-setting), collect feedback about where students are in relation to those targets (performance phase monitoring), and prompt adjustments to instruction by teachers as well as changes to learning processes and revision of work products by students (appraisal phase adjustments and revisions). Drawing on Sadler (1989), Hattie and Timperley (2007) summarize this regulatory process in terms of three questions to be asked by students: Where am I going? How am I going? and Where to next?

Examinations of these connections between assessment and SRL began in the early 1990s and have been mostly unidirectional, with scholars of FA expanding the reach of assessment to include SRL. It is widely recognized by scholars in both fields though that their interests are reciprocal, and there are benefits to combining them (Andrade, 2013; Panadero & Alonso-Tapia, 2013). Our aim is to identify keystone publications that moved the field toward a fusion of SRL and assessment, illustrating current understandings and pointing toward future research. We will explore theoretical and empirical reviews to chart significant developments.

Method

Selection of studies

As a first step, the three authors independently nominated papers that we considered important to the development of the field of FA/SRL because they explored some combination of elements of both fields. A list was created with 53 publications. After the removal of sources that were empirical research reports and/or not focused on FA and SRL, the list included 32 publications plus a symposium presented at the American Educational Research Association (AERA) in 2014.

In order to ensure complete coverage of the subject, a search of the PsycINFO and ERIC databases was performed in November 2017. This was done as a validity check to ensure that we were not missing relevant papers. The following combinations of keywords were used: Review + Assessment + Metacognition (PsycINFO 40, ERIC 78); Review + Assessment + SRL (PsycINFO 16, ERIC 16); Review + Formative Assessment + Self-Regulation (PsycINFO 2, ERIC 5); Review + Formative Assessment + SRL (PsycINFO 1, ERIC 3); Review + Formative Assessment + Metacognition (PsycINFO 0, ERIC 6). After excluding repeats and sources that did not fulfill two of our criteria—peer-reviewed journal article or book chapter and written in English—the total was 68 publications. None of them met our third inclusion criteria: theoretical or empirical review or model of FA/SRL. Interestingly, none of the 33 sources on our original list turned up in the database searches, which suggests that keyword searches are not sufficient. While a search not using the term "review" would have produced a higher number of sources, our research aim was to examine publications that that represented advances on our FA/SRL knowledge.

Results

Table 1 contains a brief summary of each source that met our inclusion criteria. Publication dates range from 1988 to 2018. Twenty of the sources are journal articles, eleven are chapters and two are conference publications. Most of the publications were published in assessment journals (e.g. *Assessment and Evaluation in Higher Education*) or books about

formative assessment (e.g. *Assessment for Learning: Meeting the challenge of implementation*).

Table 1

Summaries of sources relevant to FA and SRL

Crooks (1988)	Crooks pointed out that classroom evaluation was worthy of study because its ubiquity and frequency gauranteed that it would have educational and psychological effects on students. This review of research on the effects of classroom evaluation on learning strategies, motivation, and achievement foreshadowed interest in the relation between assessment and SRL: "increasing attention is being given to evaluation of the processes teachers and students use in the pursuit of learning outcomes. This is certainly an area that should not be neglected: Many studies reviewed here demonstrate that the learning strategies students adopt are powerful predictors of educational outcomes, so that expertise in the selection and application of learning strategies is an important educational outcome" (p. 441).
Sadler (1989)	Sadler wrote about formative assessment in the hands of students, for the purpose of developing their capacity to monitor and improve their own work and learning. Although he did not use the term *self-regulated learning*, self-monitoring is the main focus of the article, which describes the conditions under which students can "judge the quality of what they are producing and… regulate what they are doing during the doing of it" (p. 121): Students must "possess an appreciation of what high quality work is, have the evaluative skill necessary for them to compare with some objectivity the quality of what they are producing in relation to the higher standard, and develop a store of tactics or moves which can be drawn upon to modify their own work" (p. 119). By using formative assessment to create these conditions, teachers can help students "transition from feedback to self-monitoring" (p. 122).
Butler & Winne (1995)	Butler and Winne explored the role of internal and external feedback in students' knowledge construction. They framed their discussion using their own SRL model. In this article, the purpose of feedback is understood as decreasing the discrepancy between student performance and the goal. Internal feedback is defined as information generated by the learner to regulate her own actions. External feedback is defined as information from an external source (e.g. teacher, peer, context, etc.). Internal feedback is influenced by external feedback. The relationship between internal and external feedback is crucial for the development of the student's self-regulation of learning. Internal feedback helps the student decide what to do when there is a perceived discrepancy between a current state and desired goals. Butler and Winne clearly established the relationship between formative use of feedback, both internal and external, and the cognitive and metacognitive processes involved in SRL, along with the presentation of a key SRL model.
Black & Wiliam (1998)	The purpose of this review was to update previous reviews (e.g. Crooks, 1988, Natriello, 1987) about the effects of assessment on a number of educational variables, including achievement. The authors noted that the field of formative assessment was not clearly defined. Therefore, they conducted an extensive physical review of 76 journals from 1987 to 1997 in order to locate relevant publications. Finally, they included 250 articles finding the effects of effective classroom assessment practices on student achievement. The authors presented a number of examples to illustrate different formative assessment practices, concluding that to have an impact formative assessment needs to be integrated into classroom practice. The review focused on how feedback was received by examining

	the role of teachers, students' perspectives and assessment by students (peer and self-assessment). SRL does not figure largely in the review; however, it was mentioned several times, especially in relationship to students' self-assessment.
Perrenoud (1998)	Perrenoud's article was written in response to Black and Wiliam's 1998 review. He explained that French-language literature historically conceptualized formative evaluation as "the individualised regulation of learning" (p. 85), and stressed the regulatory function of formative assessment throughout the article, e.g., "the pupil becomes an important source of auto-regulation, controlling and even dispensing with external feedback" (p. 90). Perrenoud cited the work of Linda Allal, who helped disseminate the French language notion of assessment as co-regulation by also publishing in English. Perrenoud noted that "formative evaluation furnishes rather the intention—even the obsession—of regulating the learning process" (p. 97), and concluded the article by asking, "why not conceptualise and observe more widely the process of regulation at work in classroom situations and the classroom organisation that underlies them? (p. 99). He also made the connection to metacognition: "Work on metacognition as a source of regulation seems to be emerging as an area of study, but it does not fully involve the regulation of learning processes" (p. 99).
Paris & Paris (2001)	This theoretical review offered a historical revision of the development of the SRL field and presented a list of SRL principles teachers should consider when designing classroom activities. The authors pointed out that not all SRL actions are positive for learning, as students do not always aim for the most "noble outcome" (p. 98). They asserted that self-assessment may be the key to incorporating motivational aspects into academic assessment. Self-assessment includes all three domains of SRL: cognitive, motivational, and affective. Many kinds of self-assessments are possible in the classroom. Students can evaluate their levels of understanding, their personal interests, and their effort and strategies used on a task. (p. 95). The authors listed a number of formative assessment practices among the SRL principles they identified, including setting appropriate goals, monitoring progress, and self-assessment.
Allal & Lopez (2005)	The purpose of this study was to review French-language literature on formative assessment for an English-speaking readership. In so doing, the authors were able to trace the development of a major shift in the conceptualization of formative assessment in the French literature. Bloom's mastery learning model (feedback + correction) was supplanted by a conception of the regulation of learning (feedback + adaptation), beginning as early as a 1977 report by Cardinet. This expanded view of formative assessment also shifted the focus of interest in formative assessment from the teacher to the student. In mastery learning, the teacher is in control of the curriculum, the test, and remedial instruction; all of this functions as external regulation for learning. In the expanded view, the student (the "self" in self-regulation) by definition is the focus. Assessment broadens from periodic mastery tests to continuous, ongoing student-involved assessment that happens during learning through self-assessment, peer assessment, and teacher-student assessment. Formative assessment thus becomes part of the learning and scaffold for it, not a separate entity.
Brookhart (2005, April)	The author reviewed literature on formative classroom assessment, searching broadly for studies about how classroom assessment informs the learning process and is used by both teachers and students. One of the several focuses of the review was how formative assessment is motivating to students. The review treated the self-regulation of learning as an aspect of motivation. Several studies

	found that self-regulation of learning and cognitive strategy use were postively related to performance on classroom assessments. Authors of these studies recommended that self-regulatory strategies as well as cognitive strategies be explicitly taught in the classroom.
Nicol & McFarlane-Dick (2006)	This article described the connections between formative assessment practices and SRL development. The authors began with Winne's SRL model (Butler & Winne, 1995) and added a component with seven formative assessment practices that they posited could help to develop SRL.
Hattie & Timperley (2007)	The authors reviewed Hattie's previous meta-analyses on the effects of feedback in academic achievement and proposed a model of feedback. They concluded that one of the main outcomes of feedback is the development of SRL. Though the authors did not use the term formative feedback, many of the feedback actions reported in this review are the ones recommended by formative assessment scholars. In their model of feedback, they include four levels at which feedback can aim to inform. One of those is labeled the self-regulation level, and it refers to feedback that helps students develop a higher understanding of their SRL processes.
Shute (2008)	Shute's review focuses on the features, functions, and effects of task-level feedback, as well as the interactions between those effects, the task, and the learner. The review culminates in lists of the features of formative feedback that promote learning. Effects of interest are student knowledge and skills in content areas, not self-regulated learning, but SRL was referenced in the section on future research, where Shute noted the need for studies of "possible self-regulatory skills and affective variables" (p. 181).
Andrade & Valtcheva (2009)	This article is based on the premise that the purposes of engaging students in formative self-assessment are to boost learning and achievement and to promote academic self-regulation. Self-assessment is a core element of self-regulation because it involves awareness of the goals of a task and checking one's progress toward them. As a result of self-assessment, both self-regulation and achievement can increase. The article lists the necessary conditions for effective self-assessment to occur, including: 1) keep it formative (no self-grading), 2) awareness of the value of self-assessment, 3) access to clear criteria on which to base one's assessment, 4) a specific task or performance to assess, 5) models, 6) direct instruction and assistance, 7) practice, 8) cues regarding when self-assessment is appropriate, and 9) opportunities to revise and improve the task or performance.
Allal (2010)	Building on her earlier work (Allal & Lopez, 2005), Allal laid out a brief description of the implications for assessment of models of regulation developed in research on learning. She built a case for co-regulation, as students' learning depends both on their own regulation of their goals and actions and on the social or contextual aspects of classroom learning. She drew two implications for assessment: first, that assessment occurs in classroom social interactions as much as with formal tools; and second, that assessment can have greater effects on learning if it is deliberately integrated into classroom learning activities.

Andrade (2010)	Andrade situated scholarship on formative self-assessment in the literature on self-regulated learning in order to: (1) bridge the gap between two related but distinct areas of inquiry, (2) illustrate how research on student self-assessment can energize the study of self-regulation by offering effective classroom practices, and (3) expand the notion of self-assessment beyond task-specific academic achievement toward broader self-regulatory ends. The chapter includes an integrated review of the literature on self-assessment and self-regulated learning, an examination of the practical implications of the research on self-assessment for self-regulated learning, a discussion of the potential for self-assessment strategies to be applied to common processes of self-regulation, including managing the cognitive, affective and environmental aspects of learning, and a list of principles for creating the conditions under which self-assessment and self-regulation can thrive.
Wiliam (2011)	Wiliam presented a history of formative assessment, including a review of the feedback literature. He traced the importance of assessment practices back to the work of scholars from the beginning of the 20th century, interrelating assessment and learning theories. Of particular interest for this review is the summary of classroom assessment reviews, from Fuchs and Fuchs (1986) until the time of publication. The author mentioned SRL in relationship to Monique Boekaerts' SRL model (Boekaerts, 2011), which he described in detail. The connection between FA and SRL is found in the claim that FA facilitates students to be owners of their learning.
Clark (2012)	This article presented a theoretical exploration of the connection between SRL and formative assessment. It explored the theoretical and even philosophical foundational aspects of the SRL field based, according to the author, in formative assessment principles.
Andrade (2013)	Andrade (2013) explored the lessons to be learned by framing assessment in terms of the regulation of learning, including goal-setting, metacognition, progress monitoring, feedback, and adjustments to learning and teaching. She introduced a model of the co-regulation of learning, a key feature of which is that students occupy a central and active role in all feedback processes, including and especially monitoring and regulating their progress toward desired goals and evaluating the efficacy of the strategies used to reach those goals. The roles played by teachers, peers, and technology in the regulation of learning via assessment are also reviewed.
Brookhart (2013)	The author discussed research on classroom assessment and student motivation to learn, in order to describe what she called a "chicken and egg" relationship. In any learning episode, assessment (especially an anticipated summative assessment) can serve as a goal; or assessment (especially ongoing formative assessment during learning) can serve as an aid to student goal-setting, monitoring, and learning. She showed how both the field of classroom assessment and the field of motivation have arrived at the realization that the learner is the major agent of and in classroom assessment. Classroom assessment research came to this place by expanding its topics of study from mostly tools and scores (grades) to include formative assessment during learning. Motivation theory came to this place through gathering together formerly separate fields of investigation (e.g., self-efficacy, attributions, expectancies) into a more inclusive

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	view of the self-regulation of learning. As understandings in each field have grown, the fields have inclined together, into a more inclusive understanding of how assessment informs learning.
Brown & Harris (2013)	The authors conducted a meta-analysis of the effects of self-assessment in academic achievement, finding a median effect between 0.40 and 0.45. They also briefly explored the effects of self-assessment in self-regulated learning. They found mixed results and concluded that the connection between self-assessment and SRL might not be as robust as theoretically suggested.
Panadero & Alonso-Tapia (2013)	This theoretical contribution explored aspects of self-assessment as both an instructional and learning strategy. It contained a list of conditions that promote self-assessment and three ways of implementing it in the classroom (self-assessment without assessment criteria, rubrics and scripts). The article also explored two aspects of the relationship between SRL and formative assessment. First, the authors argued that the formative assessment and SRL fields approach the same phenomena, self-assessment, from two different perspectives. While the formative assessment approached self-assessment from an instructional point of view (i.e. what to do to promote self-assessment in our students, the SRL field approached from a "internal" perspective focusing in the processes that students perform during self-assessment that further strengthen their SRL processes. Secondly, the article explored how usual formative assessment practices (e.g. clarifying learning goals) influence SRL processes by presenting clear examples for each of the SRL phases (forethought, performance and self-reflection).
Panadero & Jonsson (2013)	This narrative review investigated the effects of rubrics on students' performance, SRL and self-efficacy found in 21 studies. According to these authors, rubrics are effective for formative assessment when they help clarify the learning goal and the criteria by which learning will be evaluated. A key aspect for this effect comes from the transparency offered via the assessment criteria included in the rubric. The use of rubrics positively affects SRL, and SRL also moderates the effects of rubrics on performance.
Andrade Brookhart, Allal, Winne, Wiliam & Azevedo (2014)	Noting that classroom assessment and self-regulated learning were related but distinct fields with much to learn from each other, Andrade and Brookhart brought Wiliam, Winne, Azevedo and Allal together for a dialogue during the annual meeting of the American Educational Research Association. The objectives of the symposium were to 1) foster cross-field conversations, 2) surface complementary and conflicting theories and research, 3) create a theory of assessment as the regulation of learning, and 4) generate ideas for future research.
Brown & Harris (2014)	In this article, the authors raised concerns about the validity of self-assessment as a summative assessment practice and recommend that it be reconsidered as a self-regulatory competence, since "self-assessment is an essential component of self-regulation" (p. 25). They proposed the development of a curriculum for self-assessment that addresses the full range of developmentally appropriate self-regulatory processes.

Panadero & Alonso-Tapia (2014)	The authors integrated formative assessment instructional strategies into Zimmerman's cyclical phases model of SRL.
Brookhart & Chen (2015)	The authors reviewed literature on the quality and effectiveness of rubrics. They found four studies that investigated the effects of using rubrics on student self-regulation or self-efficacy, an important construct in most theories of the self-regulation of learning. Each study demonstrated that rubrics have positive effects on self-regulation or self-efficacy, but not in all cases and with all measures. Interpreting this finding in light of other studies about the effects of rubrics on achievement, the authors hypothesized that the important aspect of rubrics might be the degree to which their quality and the process involved as they are used focuses students on the learning goal and clarifies the goal for them.
Allal (2016)	This chapter focused on how the processes of co-regulation of student learning and assessment for learning jointly influence each other and the assessment culture in a classroom. Allal defined assessment culture as the teachers' and students' beliefs, teacher assessment practices, and the assessment tools that support or inhibit those practices. Defining the regulation of learning as she had previously (Allal, 2010), she made two claims (p. 264): (1) all learning in the classroom is co-regulated; and (2) nevertheless, the processes of self-regulation are the core mechanism of learning. She proposed a model of the co-regulation of learning and its links with assessment for learning. The model is nested, with self-regulation of learning at the heart, inside, respectively, peer interaction, teacher regulation, and regulation from the teaching/learning context. The various levels are linked together by assessment tools. The chapter also introduced and synthesized five other chapters on assessment culture and the co-regulation of learning in the book, all of which were generally consistent with Allal's model, providing more detail and research evidence for the Allal's claims.
Andrade & Brookhart (2016)	This chapter is based on the premise that self-regulated learning depends, in part, on information gleaned from classroom assessments about student learning and achievement. The authors drew on the literature on classroom assessment and SRL to demonstrate how assessment contributes to each phase of self-regulation, defined as: 1) goal setting, 2) progress monitoring, and 3) revision and adjustment. For example, the goal-setting phase is influenced by the learning goals and success criteria teacher shares with students. The progress-monitoring phase is affected by feedback provided via formative and summative assessments. The revision-and-adjustment phase is affected by opportunities teachers give students to use feedback, and the decisions students make based on that feedback. The chapter demonstrated the close relationship between classroom assessment and SRL, and makes the case that assessment can support the self-regulation of learning in classroom settings.
Dinsmore & Wilson (2016)	This narrative review explored the role of student's participation in assessment (e.g. self-assessment) in SRL. The results of the review were mixed. The authors suggested three lines of future research. First, future research should explore developmental aspects of SRL, focusing on both intra-individual differences over time (i.e. how the same individual develops) and on younger students' involvement

	in assessment. Second, they questioned whether the aspects of the students' involvement in assessment can be separated to study them in isolation. Third, they advised considering the relationship between assessment and SRL as a reciprocal one in future research.
Panadero, Jonsson & Strijbos (2016)	This publication is a non-exhaustive literature review of the connections among peer and self-assessment and SRL. The authors first briefly summarized the theoretical and historical connections between FA and SRL. Then they reviewed the connections between FA and SRL in relationship to self-assessment. They concluded that the FA and SRL fields have approached the same phenomena (especially self-assessment) with different lenses. The authors synthesized the evidence of the effects of self-assessment on SRL and into a list of guidelines for implementing self-assessment. Then the authors synthesized the evidence of the relationship of the effects of peer assessment on SRL and co-regulation into a list of implementation guidelines for peer assessment.
Reinholz (2016)	The author explored how peer assessment practice enhances self-assessment via self-reflection. His review showed how the fields of formative assessment and SRL used different approaches to self- and peer assessment to make similar points. Then, he presented three empirical cases to support the claim that peer assessment enhances self-assessment. The author used Kollar and Fischer's (2010) six-phase peer assessment feedback cycle as the framework for his discussion: task engagement, peer analysis, feedback provision, feedback reception, peer conferencing and revision.
Panadero, Jonsson & Botella (2017)	This meta-analysis explored the effects of self-assessment on SRL and self-efficacy. The authors included different instructional implementations of self-assessment. Most of these were formative, although a few were not (i.e. simplistic approaches only asking students to self-grade). Additionally, the authors separated SRL and self-efficacy, even though the latter is usually considered an aspect of the former. For the three different SRL measurements considered, the effect sizes were 0.23, 0.65, and 0.43, respectively. The effect size for self-efficacy was 0.73 regardless of the "quality" of the self-assessment intervention.
Panadero & Broadbent (2018)	The authors explored the relationship between evaluative judgement (i.e. the ability to assess a piece of work (one's own or that of others) while attending to the context, quality, standards and criteria built upon previous experience) and the development of SRL skills. The authors claimed peer and self-assessment are key to the development of evaluative judgment, using Zimmerman and Kitsantas's (2005) multi-level model of the development of SRL as the theoretical framework. This model explores four levels along which SRL develops: observation, emulation, self-control and self-regulation. The authors proposed that, as peer and self-assessment are skills that need practice, the same four phases can be applied in their development.
Andrade & Brookhart (under review)	This literature review gives substance to a theory of classroom assessment as the co-regulation of learning by teachers, students, instructional materials, and contexts. The literature is organized using a version of Pintrich and Zusho's (2002) theory of the phases and areas of the self-regulation of learning, expanded to include the co-regulation of learning, in order to demonstrate the reciprocal relationship between classroom assessment and all aspects of the regulation of learning.

Discussion

Analysis of the content and timing of the publications included in Table 1 reveal how scholarship on FA and SRL has inclined together over the years. Figure 1 places each source on a timeline and introduces stages in the development of FA/SRL as a field. We have identified three phases in this development that culminate in the present state of affairs, at which the joint investigation of FA and SRL has become an established area of inquiry.

Figure 1. **Formative assessment and self-regulated learning publications timeline**
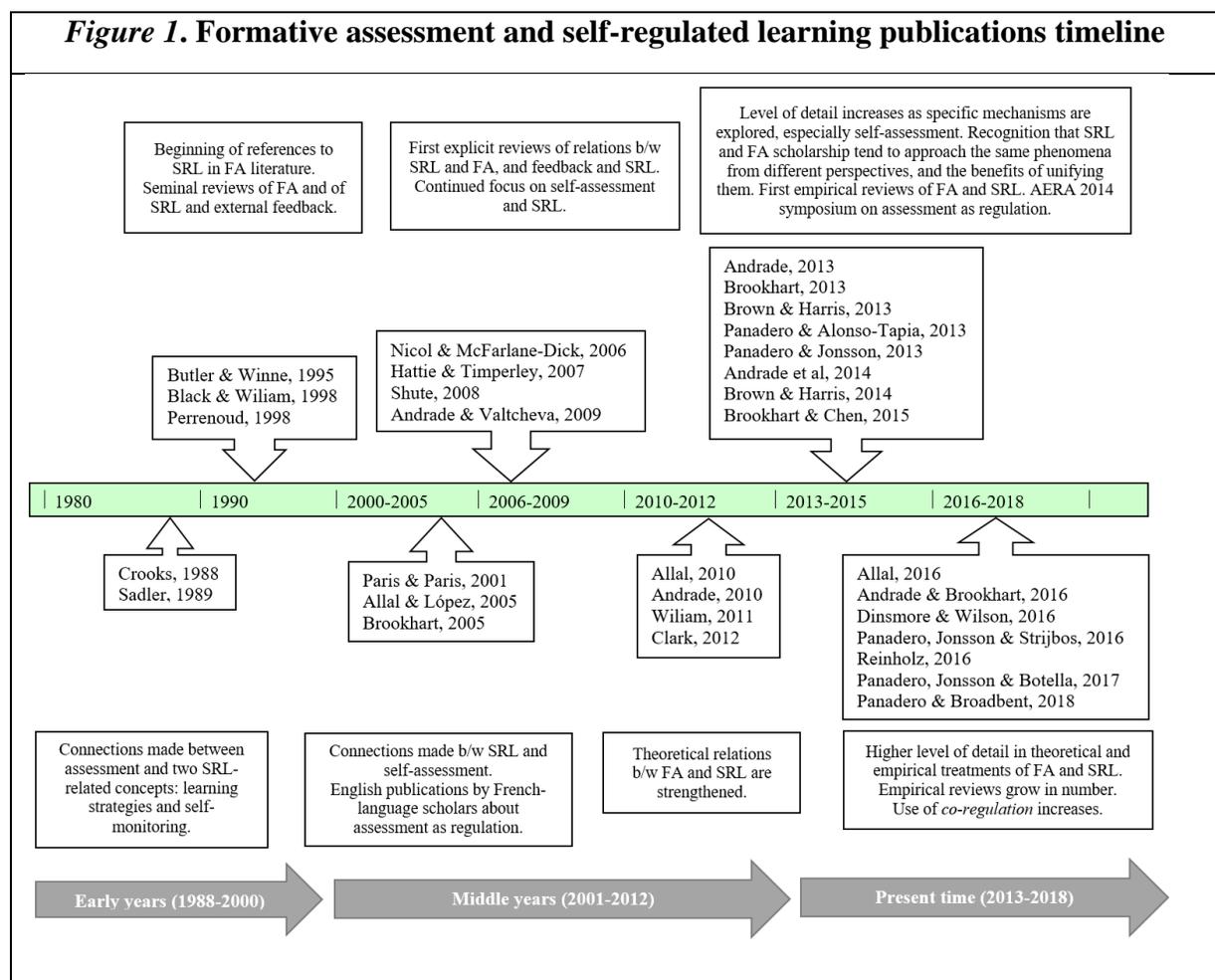
Early Years (1988-2000)

The first two widely read English-language publications that related assessment to aspects of SRL were published in the late 1980s by assessment scholars in New Zealand and Australia. Crooks (1988) and Sadler (1989) each focused on how to turn classroom assessment into opportunities for enhancing student learning. Self-regulated learning was still

an emerging field at the time (Pintrich, Wolters, & Baxter, 2000), so the term was used only twice by Crooks, who discussed learning strategies, and not at all by Sadler, who referred to self-monitoring. Strategies and self-monitoring are key aspects of SRL, however, so the initial steps toward linking the two concepts had been taken.

Two other publications about FA from the 1990s are related to SRL. The landmark review of formative assessment by Black and Wiliam (1998) is often credited with triggering the popularization of the field. The authors used the term *self-regulated learning* four times, *regulation* and *strategies* many times, and explicitly stated that one reason for implementing formative assessment is enhancement of self-regulated learning. Perrenoud's (1998) article was a response to Black and Wiliam (1998) in which he pointed out that the French-language literature on assessment had long conceptualized assessment as regulation. He placed special emphasis to the work of Allal, who subsequently shared the Francophone view on FA and SRL with others by publishing in English (e.g., 2005, 2010, 2016).

Much of the foundational work on FA and SRL during the early and middle years was done by assessment scholars, but they often drew on an important review of the association between external feedback and SRL that was written by SRL researchers (Butler & Winne, 1995). Butler and Winne clearly established the relationship between feedback and the cognitive and metacognitive processes involved in SRL—a keystone concept in all subsequent discussions of assessment as the regulation of learning (Allal, 2016; Andrade, 2013; Andrade & Brookhart, 2016; Panadero & Alonso-Tapia, 2013).

Middle years (2001-2012)

The first decade of the 21st Century was when both SRL and FA became well established fields in educational research. The idea that assessment affects the regulation of learning began to get traction in the English literature, and several publications plumbed deeper connections. Brookhart (2005) pointed out that control over one's learning is

motivational, and that formative assessment contributes to student motivation by providing information to students. Allal and López (2005) introduced modalities of regulation (interactive, retroactive and proactive) and forms of student involvement in assessment (self-assessment, reciprocal peer assessment and co-assessment).

Student involvement in FA became a particularly rich vein to mine, given the stronger links between SRL and student-centered FA, which provides feedback to students, than teacher-centered FA, which informs only (or mostly) the teacher. Self-assessment was recognized as a practical link between FA and SRL during the middle years. Paris and Paris (2001) claimed that "self-assessment involves the internalization of standards so students can regulate their own learning more effectively" (p. 95) and proposed a number of instructional practices to ensure students would develop such capacity. Andrade and Valtcheva (2009) asserted that self-assessment is a core element of self-regulation, and listed the conditions for effective self-assessment in the classroom. Study of the role of formative self-assessment in promoting SRL has continued to today (Andrade, 2010; 2013; Brown & Harris, 2013, 2014; Panadero & Alonso-Tapia, 2013; Panadero, Jonsson & Strijbos, 2016; Panadero, Jonsson & Botella, 2017; Panadero & Broadbent, 2018).

Four influential reviews were published in the second half of the 2000 decade. Nicol and McFarlane-Dick (2006) performed a theoretical review of formative assessment and SRL that might be the first to include both FA and SRL in its title. Two reviews of research on feedback were also performed (Hattie & Timperley, 2007; Shute, 2008). Shute's review of formative feedback made passing references to metacognition, regulation and strategies, but did not use the term *self-regulated learning*. Hattie and Timperley (2007) developed a model of four levels of feedback that included a self-regulation level, thereby acknowledging the role of feedback about the self-regulation of learning in helping students learn and develop SRL skills.

By 2010, the conceptual link between FA and SRL was firmly established. Andrade (2010) explicitly bridged the gap between FA and SRL by situating scholarship on formative self-assessment in the literature on self-regulated learning. Allal (2010) expanded the concept of self-regulation via assessment to include assessment by teachers and peers, and introduced the term *co-regulation* in the context of educational assessment to English-speaking readers. Wiliam's (2011) review of FA drew on Boekaerts' (2011) model of SRL, and Clark (2012) provided a theoretical review of the influence of formative feedback on SRL. FA and SRL had become an area of research in its own right, and its theoretical foundation was being deepened and strengthened.

The Present Time: FA and SRL as an Established Area of Research (2013-2018)

As indicted in the timeline in Figure 1, the number of publications in which the main or only topic is FA and SRL is now quite high. We have included only peer-reviewed theoretical manuscripts and empirical reviews published in English in this paper, but there are also numerous empirical studies that sustain and develop our theoretical understanding (e.g. Baas, Castelijns, Vermeulen, Martens, & Segers, 2014; Meusen-Beekman, Joosten-ten Brinke, & Boshuizen, 2016; Tay, 2015).

In 2013 five relevant publications appeared, two of them empirical reviews (Brown & Harris, 2013; Panadero & Jonsson, 2013). One indicator of the trend toward establishing an empirical base is the fact that three of the 2013 publications were chapters in McMillan's *SAGE Handbook of Research on Classroom Assessment* (Andrade, 2013; Brookhart, 2013; Brown & Harris, 2013). Although each chapter rested on a different model of SRL, all three were able to draw on research to support claims about the associations between it and FA. By 2017, there was a sufficient body of research to permit Panadero, Jonsson and Botella to perform a meta-analytic review of the influence of self-assessment training on SRL and self-efficacy.

Panadero and Alonso-Tapia (2013; 2014) pointed out that scholars in SRL and FA were approaching the same phenomena with different lenses. It was time to initiate inter-disciplinary cross-talk, so Andrade and Brookhart organized a symposium at the 2014 meeting of the American Educational Research Association and invited eminent SRL and FA scholars to participate. As a result, the new field of FA and SRL had a presence at AERA.

In the following years, theoretical papers explored more fine grained mutual influences (Andrade & Brookhart, 2016; Panadero & Broadbent; 2018; Reinholz, 2016), and empirical articles demonstrated that the connection is supported by evidence (e.g. Baas, 2017; Hawe & Dixon, 2017), although there is much to be explored. Practical instructional strategies that drew on FA to support SRL were proposed and/or tested, particularly self-assessment (Brown & Harris, 2014; Panadero et al., 2017), peer assessment (Panadero, Jonsson & Strijbos, 2016; Reinholz, 2016), and rubrics (e.g. Brookhart & Chen, 2015).

All the while, Allal (2016) has continued to push us to think about assessment as a matter of co-regulation with teachers and peers, rather than an artificially isolated act of self-regulation by lone students. This notion of assessment as the co-regulation of learning is fleshed out in a manuscript by Andrade and Brookhart that is currently under review.

Where to Next? Future Lines of Scholarship

Although the evolution of the field is clear, there are still a number of paths to travel. First, it would be useful to go beyond our broad stroke definitions of FA and SRL and explore the influence that different models of each contribute to their relationship. Questions of interest include which models of SRL most effectively align with and underpin productive FA practices, and what practices considered to be formative actually help students self-regulate their learning and under what conditions.

Similarly, the question of possible variations in FA/SRL relationships should be examined, such as the sector of education and age of the learners (e.g. Kindergarten, higher

education) and contextual factors (e.g., one-to-one tutoring vs. classrooms of 25 or more students vs. large-scale online courses). Up to now, most SRL and FA publications tend to present their conclusions as if they are universally valid. More attention should be given to documenting and interpreting the variations across different educational levels and contexts.

It would also be useful to generate scholarship that assumes a mutual influence: Current models emphasize how formative assessment can influence SRL, but SRL skills are needed to take full advantage of student involvement in assessment. This reciprocal relationship should be explored in detail. We should be asking questions about how SRL (or its absence) influences the uses and results of FA.

We also need to examine the psychological and social effects of FA to better understand what happens with SRL. What types of mental and emotional processes do students activate when self- or peer assessing? How do those processes influence the activation of learning strategies? Interest in this type of research is growing, as demonstrated by the publication of a recent handbook on the human and social factors of assessment (Brown & Harris, 2016). Only by understanding internal cognitive and affective processes can we truly understand the power of FA.

In addition, we need to employ more rigorous experimental designs, while continuing to develop the kinds of strong, ecologically valid quasi-experiments that have brought us most of our insights (Wiliam, 2017). New research should take advantage of the latest advances in SRL measurement, including and especially online measures that combine measurement and intervention using the latest technologies (Panadero, Klug & Järvelä, 2016). However, alternatives to self-report measures are needed in order to resolve persistent problems regarding the validity of SRL measurement (Roth, Ogrin, & Schmitz, 2016; Veenman, 2011). FA/SRL research should use all the accumulated knowledge about the latest advances of SRL

measurement, including thinking-aloud protocols, trace methods, and observations, to ensure valid and rich conclusions.

Finally, the intersection between formative assessment and co-regulation deserves more empirical study. Compelling theoretical connections have been made (Allal, 2010, 2016; Reinholz, 2016). It is time to study the relationship in classrooms.

The fusion of FA and SRL has been done primarily by FA scholars, many of whom had little training in SRL. Happily, there is now a new generation of educational researchers who are working in the intersection of the fields of FA and SRL. They have the benefit of knowledge of both fields, as well as well-developed models to test. It is our hope that the new generation will push FA/SRL to its full potential.

<div align="center">**References**</div>

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