REFLECTION ON THE FIELD

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Teachers' and Students' Belief Systems About the Self-Regulation of Learning

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Abstract

Contemporary theories of learning and instruction emphasise the importance of students knowing how to effectively regulate their learning. A large body of research indicates that effective regulation of learning is beneficial for achievement. Set against this research are findings showing that the promotion by teachers of strategies for the self-regulation of learning (SRL), and student use of these strategies, is less common than might be expected. We review this research on the promotion and use of SRL strategies and suggest that a range of beliefs about learning and SRL strategies limit the promotion of SRL learning strategies by teachers. This contributes in turn to the lack of knowledge and use of such strategies by students. These beliefs are represented as forming an interrelated system that needs to be made explicit and examined in order to increase the level of SRL strategy promotion and use. Each of the beliefs is described and the paper concludes with discussion of the implications of the review for teacher educators, teachers, students, school leaders, curriculum designers and researchers.

Keywords Self-regulated learning · Beliefs · Teaching strategies · Learning strategies

> Our complex and rapidly changing world creates a need for self-initiated and self-managed learning. Knowing how to manage one's own learning activities has become, in short, an important survival tool. (Bjork et al. 2013, p. 418)

The self-management, or self-regulation, of learning, referred to by Bjork et al. (2013) is a central feature of most contemporary theories of learning and instruction. Findings from research based on theories of self-regulation of learning (SRL) provide evidence that the teaching of SRL learning strategies to students can have a positive impact on student

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achievement. Despite this evidence, there is also research that suggests it is not used in many school and university classrooms. Indeed, while emphasising the importance of effective SRL, Bjork et al. (2013) set out evidence that shows that many learners have "faulty mental models of learning and remembering" (p. 417) that compromise the effective management of their learning.

Like Bjork et al., we are puzzled as to why there is not more widespread teaching about, and use of, knowledge of effective SRL learning strategies in classrooms. Given the availability of evidence about the benefit associated with use of SRL strategies, why do some students and teachers continue to use and promote a limited range of SRL strategies that inhibit high-quality knowledge development? In this paper, we present a brief review of research on promotion and use of SRL strategies and then consider a range of teacher, student and researcher beliefs about the relationship between SRL teaching and learning. We represent these beliefs as a system of interrelated beliefs that limits teacher SRL promotion, and thus student use, of SRL strategies. In the final section, we discuss implications of the review for the design of teacher education programmes, teachers, students, school leaders, curriculum designers and for researchers working with schools.

In keeping with the aims of the journal, this paper is a theoretical reflection on this field. It is not a meta-analytic review. It is based on a systematic review of published research on the self-regulation of learning, including research on the promotion and use of self-regulated learning by teachers. It reviews research on teacher and student beliefs and knowledge about SRL. Our search included relevant databases, specifically PsycINFO and ERIC, as well as research referenced in major reviews of SRL. The focus of our discussion is the educational research on SRL. There are other streams of cognitive psychology research on the regulation of learning, such as that on judgements of learning (see Bjork et al. 2013) and research in the field of cognitive control (e.g. Botvinick and Braver 2015; Chein and Schneider 2012; Gratton et al. 2018; Logan 2017). However, that research is not reviewed in this paper.

The Self-Regulation of Learning

Usher and Schunk (2018) provide a broad perspective on SRL referring to it as "The process of systematically organizing one's thoughts, feelings, and actions to attain one's goals" (p. 19). There are several major theoretical models that provide more specific accounts of SRL and its role in classroom teaching and learning (e.g. Boekaerts 1997; Efklides 2017; Mayer 2017; Pintrich 1999; Schunk and Zimmerman 2013; Winne 2001), there being substantial overlap in these different models (Panadero 2017). Although these models do differ in specific details, such as in the emphasis given to affect (e.g. Efklides et al. 2018), there are common categories of learning events included in each: emotional, motivational, cognitive, metacognitive and behavioural events. There is also a reasonable degree of consensus about the types of processes involved in effective self-regulation of learning: consideration of the context, affective and motivational states, management of resources, setting goals, establishing a plan for action, selecting strategies, elaboration and organisation of knowledge, monitoring of activity and evaluation of outcomes. Common to these processes is their management of learning by the individual. As Winne (2018) notes, in *self*-regulation "the learner is in charge" (p. 40). This emphasis on *self* recognises that the regulation of learning can also be shared with others or be mostly directed by others (Hadwin et al. 2018), an issue that we will not consider here.

The instructional significance of the teaching and use of effective SRL strategies is shown in their impact on student achievement. In major reviews (e.g. Bjork et al. 2013; Dunlosky et al. 2013; MacArthur 2012; Schunk and Greene 2018; Winne 2018), in meta-analyses (e.g. Hattie 2009; Sitzman and Ely 2011), in cross-national comparative research (e.g. Perry et al. 2015a, b), in reviews of strategy interventions (e.g. Greene et al. 2015; Morehead et al. 2016) and in textbooks (e.g. Bruning et al. 2011; Mayer 2008), there is a strong body of evidence showing that teaching students how to use effective SRL strategies can improve student achievement. Skill in use of SRL strategies has been identified as a key difference between more successful and less successful learners (Greene et al. 2008). The benefits of explicit teaching of SRL strategies are also present in research on cognitive control (e.g. Birk et al. 2018; Hussey et al. 2017; Mayer 2017). In Zimmerman's (2002) words "Recent research shows that self-regulatory processes are teachable and can lead to increases in students' motivation and achievement" (p. 69).

Expectations That Students Should Have Detailed Knowledge of SRL Strategies

The term " SRL strategies" is used here to refer to processes, activities or procedures that encompass the range of actions learners can take automatically or deliberately during learning. This sense of the term is similar to that adopted in research on learning strategies by Glogger-Frey et al. (2018). In other contexts, there may be situations where distinctions need to be made between closely related terms like self-regulation, self-regulated learning, metacognition and approaches to learning (Alexander 2018; Coertjens 2018), though these distinctions are not the focus of this paper.

Atkinson and Shiffrin (1968) reviewed research on human memory and gave explicit recognition to the key role of control processes, or strategies, in learning, defining these as "transient phenomena under the control of the subject" (p. 30). This recognition of strategies being under the control of the learner is central to the idea of learning involving moment-to-moment self-regulation. Since the time of Atkinson and Shiffrin's paper, research on SRL strategies used during learning has been a major focus in psychological research on learning and instruction (Mayer 2017).

Researchers' expectations that teachers and students would have detailed knowledge about learning strategies have been explicit in the literature on teaching for several decades. Norman (1980) pointed out that "it is strange that we expect students to learn yet seldom teach them to learn" (p. 97) and argued that students need to be taught how to learn. Weinstein and Mayer (1986) extended this argument, identifying goals related to learning processes as a priority for classroom teachers. Pressley et al. (1989) argued that learning strategy instruction should be "explicit and comprehensive" (p. 864), based on the principles of Pressley's (1986) Good Strategy User Model. The focus of Weinstein and Mayer's paper was a conceptual framework that made explicit the importance of teacher (and student) knowledge about specific affective, motivational, cognitive and metacognitive learning strategies that would enable students to learn how to learn. Learning how to learn and learning strategies became the focus of publications describing practical classroom methods in schools and universities (e.g. Brown et al. 1980; Novak and Gowin 1984; Pintrich et al. 1987; Pressley et al. 1989) and a topic of significance in educational systems, including being mandated as a focus for teachers in education in some countries (e.g. in Belgium: Waeytens et al. 2002; in USA: National Council

for the Accreditation of Teacher Education 2008). This call for explicit and repeated teaching of SRL strategies is still being made in order to give students a strong basis for maximising their achievement (e.g. Finley and Benjamin 2012; Lipsey et al. 2017).

The State of Knowledge and Use of SRL Strategies

Durkin (1978) provided an early account of a situation where teachers of reading comprehension in a range of grades and curriculum areas showed almost no explicit teaching of learning strategies for comprehending text. Rather, the teachers Durkin observed relied on students to use any learning strategies they knew to address the tasks set out in class worksheets. Rather than being seen as providers of explicit instruction on procedures for comprehension, Durkin described the teachers she observed as "mentioners", "interrogators" and "assignment givers" (p. 50).

Similarly, in a review of the impact of her own learning strategy research, Brown (1994) noted that the then new cognitive theory of learning was not making the expected level of impact on classroom practice in the USA. Brown was quite pessimistic about the spread and impact of her research on reciprocal teaching and the development of communities of learners in schools. A similarly pessimistic view was expressed much later by Hattie (2009, p. 3) who was puzzled that the "bounty of research" he had reviewed in a large meta-analysis, including findings showing practically significant effects on classroom achievement of SRL strategy instruction, had shown minimal impact on classroom practice. Hattie and Yates (2014) argued that the proportion of time spent teaching about learning strategies (they suggested about 5% of classroom time) was inadequate if the effects of strategy use demonstrated in research were to be replicated in everyday classroom lessons. And in a very recent study of comprehension knowledge of pre-service teachers, Glogger-Frey et al. (2018) describe a situation that shows little advancement on the account provided by Durkin 40 years earlier. These accounts and evidence reviewed below suggest that the amount of explicit promotion and use of SRL strategies is not changing very quickly.

Exceptions to this account must be noted. Systematic programmes for teacher development that incorporate the promotion of SRL have been enacted. Australian researchers have developed valuable programmes involving elements of SRL for teachers, such as the Program for Enhancing Effective Learning (PEEL: Mitchell and Mitchell 2008), Visible Learning programmes (Hattie et al. 2016), the Productive Pedagogies framework (Hayes et al. 2005) and the instructional rounds project based on the Quality Teaching framework (Gore 2014). In Canada, Perry et al. (2015a, b) have developed a participatory approach that sets up a long-term partnership between teachers and researchers, enabling them to work together on SRL. In the US, programmes such as the Self-Regulated Strategy Development (SRSD) model for the development of student writing (Harris and Graham 2009) have been used with positive effects by schools. Tuckman and Kennedy (2011) have also shown longer term beneficial effects of learning strategy instruction for US university students. Yet despite the evidence that SRL strategies can be integrated into classroom lessons with beneficial effects (e.g. Berglas-Shapiro et al. 2017; Spörer and Brunstein 2009), this practice does not seem to be widespread.

School Students' Knowledge and Use of SRL Strategies

In reviewing his SRL research in Canada, Winne (2014) noted that students rarely have access to a variety of effective SRL tactics and strategies, noting that this was likely due to the fact

that these were taught infrequently in classrooms. Earlier, Cleary and Zimmerman (2004) put the same view, arguing that this was problematic for struggling students who have a more limited range of effective strategies and are less able to make appropriate adjustments to strategies. Research on the development of SRL strategy knowledge, both cross-sectional and longitudinal, suggests that the rate of development of such knowledge in the school is often quite low. In cross-sectional research, Askell-Williams et al. (2012) found that students' transitions from primary school to secondary school were associated with a lower frequency of use of SRL strategies. When Karlen et al. (2014) tracked a group of Swiss secondary school students across one academic year, they found no significant increase in SRL strategy knowledge across the year. The same finding emerged in the study by Askell-Williams and Lawson (2015) who tracked students across five years of secondary education: Students' reports of use of SRL strategies did not show the expected pattern of growth. More recently, Schneider et al. (2017) examined changes in declarative metacognitive knowledge of German students across grades 5–9. Although the students' metacognitive knowledge did increase across that period, most of the growth occurred in the earlier grades, with less growth in the later secondary grades. de Bruin and van Merriënboer (2017) suggested that this profile of strategy use is not uncommon and that, generally, school students have difficulty in effectively monitoring their learning and being strategic in the decisions they make about their learning.

University Students' Knowledge and Use of SRL Strategies

Findings from research on learning strategies and their use by university students suggest that many do not exploit the available knowledge about SRL learning strategies. Undergraduates have had many years of formal education and might be expected to have developed knowledge about effective ways to learn, knowledge similar in depth to the knowledge they have developed in their major fields of study. However, in some cases students do not show awareness of the effectiveness of SRL strategies they use and so do not use such strategies when it would be opportune to do so, or they stop using these strategies before they should. Research on students' testing of their memory for previously studied information provides an example. Retrieval practice has been shown to enhance retention through practice and enhanced encoding. When Karpicke (2009) placed undergraduate students in a situation where they had control over their study procedures and where retrieval practice would be an effective strategy, many students did not use that strategy, or began to use it and then swapped to the use of a less effective strategy. In related research, Kornell and Bjork (2007) found that students did not appreciate the benefit that could be generated by spacing their practice of learning material. McCabe (2011) also found that undergraduate students lacked effective metacognitive knowledge related to a range of study strategies and reported that they used learning strategies that were not optimal for common study tasks (see also Hartwig and Dunlosky 2012; Karpicke et al. 2009). The chemistry students in research by Lopez et al. (2013) seldom used productive elaborative, metacognitive monitoring or peer learning strategies, showing most frequent use of strategies involving review of past learning. Karpicke et al. (2009) also found that reviewing was a strategy used by most students in their study, but that these students did not show awareness of the more powerful ways that such review could be extended, such as through use of self-testing. One effect of this lack of awareness suggested by Karpicke et al. was that students were likely to experience "illusions of competence", thereby over-rating their levels of understanding. In research by Foster et al. (2017), the pattern of reliance on non-optimal SRL knowledge was found to be long lasting and this has also been

observed in people outside universities (Bjork and Yan 2014; Herzog 2016). Where the likelihood of students moving toward more effective use of SRL strategies has been examined, Fryer and Vermunt (2018) found that there were a substantial group of university students who maintained low-quality strategies across the study period. McCabe (2018) surveyed a large number of academic support units at universities to ask staff to rate the effectiveness of a range of learning strategies that students could use in their studies, describing the results of these self-reports as mixed. Although high ratings were given to several strategies for which there is good evidence of effectiveness, there were also similarly effective strategies that were given low ratings.

These findings give support to the view that many school and university students, and some of their advisors, have poor levels of knowledge about effective SRL strategies that may lead to continuing use of the 'faulty' mental models of self-regulation noted by Bjork et al. (2013).

Pre-service Teachers' Knowledge About SRL Strategies

In the USA, Woolfolk-Hoy and Tschannen-Moran (1999) observed that their prospective teachers had difficulty "explaining the mechanism of learning and how teaching influences these processes" (pp. 280–281). Similarly, Elen and Lowyck (1999) reported that their teacher education students in the Netherlands did not "have articulate conceptions about the way in which an instructional environment may support their cognitive processing and/or control activities" (p. 157). These difficulties in providing explanations about the process of learning and how teaching can facilitate effective management of learning seem to be characteristics of a poorly developed knowledge base. If prospective teachers had well-developed knowledge about SRL and its facilitation during teaching, it might be expected that such difficulties would not be evident. Yet research in other countries suggest that these difficulties continue to be observed. Ohst et al. (2015) have argued that pre-service teachers have fragmentary, disorganised and sometimes inaccurate knowledge about learning and metacognitive strategies that can be difficult to change. In their work with pre-service teachers in Germany, they found that, prior to an intervention programme, the teachers' showed low levels of knowledge about learning strategies. In more recent work on comprehension, Glogger-Frey et al. (2018) found low levels of good quality knowledge about strategies for comprehension. Half of their participants did not mention any strategy and some confused the strategic actions of the student with actions that would be carried out by the teacher.

Other descriptive studies of pre-service teachers' knowledge provide similar findings. Lawson and Askell-Williams (2001) asked Australian final-year pre-service teachers what most helped their learning at university. Students identified many different activities, but these did not range across all the components of SRL, with the motivational component being absent from most reports. In a more recent survey (Van Deur et al. 2016), Australian pre-service teachers were asked to nominate strategies they found useful for learning, and to explain how those strategies helped them to learn. Most of the reports of strategies were phrased in everyday terms with very little use of the technical language of the field. In half of the explanations of how these strategies enabled learning, it was not possible to identify any link to a component of SRL. The most common strategies reported involved note taking, repetition, revision and reading. Reports of motivational, metacognitive and problem-solving strategies were infrequent. As was the case in the reports of Woolfolk-Hoy and Tschannen-Moran

(1999), and Elen and Lowyck (1999), this more recent research suggests that many pre-service teachers need to develop their knowledge about SRL further to stimulate effective SRL actions in their students.

Practising Teachers' Knowledge and Promotion of SRL Strategies

Research with practising teachers points to a similar conclusion. Observational studies of elementary teachers (Moely et al. 1992; Spruce and Bol 2015) and middle school teachers in the USA (Hamman et al. 2000) show infrequent teaching of SRL strategies. A more recent observational study of primary and secondary German teachers showed very little direct instruction of SRL strategies, with instruction being mostly implicit and focussed on cognitive strategies (Dignath and Büttner 2018). In that research, no explicit instruction of SRL strategies was observed among the primary school teachers. Surveys of teachers show comparable findings, with many teachers not incorporating SRL principles into their teaching (e.g. Grigal et al. 2003; Wehmeyer et al. 2000; Cleary and Kitsantas 2017).

When Waeytens et al. (2002) investigated Belgian teachers' views of learning to learn, they found that most did not have a broad vision of that topic that would indicate well-developed knowledge related to SRL. Rather, the majority of the teachers viewed their role as providing students with "tips and general advice" (p. 319). Dignath-van Ewijk and Van der Werf 2012 suggested that "the area of direct strategy instruction has somehow got lost in teachers' minds (or has never existed)" (p. 8). The Dutch teachers in Dignath-van Ewijk and van der Werf's study were positively disposed to SRL but did not show evidence of knowledge of how to foster it in their classrooms, and did not assess how students used SRL strategies (see Bolhuis and Voeten 2001; Dignath and Büttner 2008). The primary and secondary teachers in Dignath and Buttner's (2018) recent study found it difficult to define motivational, cognitive and metacognitive strategies, showing least knowledge about metacognitive strategies. With respect to teacher knowledge of learning strategies, Griffin et al. (2012) found that a large group of Australian elementary school teachers could generate suitable teaching and learning strategies in mathematics and reading for low achieving students, but not for top-performing students.

In Hora's (2014) study of the views about learning held by university staff in science and mathematics, reports showed knowledge of a restricted range of learning strategies, focussing mostly on practice, perseverance, learning styles and hands-on experience, and a low level of reporting of strategies related to organisation and integration of knowledge and motivation. Similar findings emerged in the comparison Morehead et al. (2016) made between the strategy knowledge of university instructors and their students: "instructors and students have modest knowledge of optimal study strategies and differ little in this regard" (p. 257).

This research with students and teachers suggests that the concerns about the spread of knowledge about SRL and learning strategies expressed by Brown (1994) have not disappeared. In a range of different teaching environments, the importance of students knowing about, and knowing how to use, effective learning strategies is still undervalued, so that the potential impact of that knowledge for student achievement is limited.

Although there is evidence that the broad ideas of SRL, and of constructivist views of learning are known and often viewed positively by teachers, this does not seem to be widely associated with the explicit promotion of these strategies in lessons. In the following sections, we consider a range of beliefs discussed in research that are predicted to contribute to the less than expected frequency of use of SRL strategies and that are likely candidates for examination and further research.

Belief Systems

In seeking to understand the puzzling situation related to the promotion of SRL strategies, our judgement is that one key area for investigation is teachers' and students' beliefs. We see that beliefs have an element of primacy in guiding teachers and student actions during class lessons. We use the term "belief system" here to refer to a range of beliefs impacting on the actions of teachers and students with regard to SRL, beliefs that form a complex and interrelated system. As a result, we think it is unlikely that change in a single belief will prove to be decisive in increasing the promotion and use of SRL strategies in classrooms.

More specifically, a *belief system* is a constantly evolving structure that covers a domain of knowledge and is activated, depending on the context, to interpret incoming information. Bandura (2001, p. 3.) described a belief system as the individual's "working model of the world" and that perspective is compatible with the representational account of beliefs advanced by Churchland and Churchland (2013). Fives and Buehl (2012) described beliefs as being represented in an integrated system, the system being likened by Churchland and Churchland to an individual's background map that is critical for navigation of the individual's world. In this account, beliefs are one among a number of forms of representation critical for guiding perception and prediction and thus influential in interpretation of events and for managing responses. In related accounts, both Ohlsson (2009) and Abelson (1979) have argued that it is often difficult to differentiate between knowledge systems and belief systems and have pointed out that the elements constituting a belief system are not "consensual", so that beliefs within a system might not be consistent with others in the same content domain. Similarly, Lombaerts et al. (2009, p. 89) noted that belief systems are not necessarily cohesive and that individuals "may hold contradictory beliefs making it difficult to determine how particular beliefs influence instruction" (see also Pajares 1992; Warfield et al. 2005). Maggioni and Parkinson (2008) provide examples of teachers simultaneously holding conflicting beliefs about knowledge and Vosniadou et al. (2017) show that this pattern also obtains for pre-service teachers' beliefs about SRL. Another feature of belief systems identified by Usó-Doménech and Nescolarde-Selva (2016) and Pajares (1992) is that they involve personal commitment and so may not be flexible, even though these commitments will vary in certitude.

It has been shown that specific teachers' beliefs exert considerable influence on their teaching practices (Pajares 1992; Ertmer 2005; Staub and Stern 2002; Patrick and Pintrich 2001; Richardson and Placier 2001). There is also evidence from recent research that beliefs influence judgements about learning that might be influential in professional learning situations for teachers (Mueller and Dunlosky 2017). Accordingly, it seems important to consider how teachers' belief systems influence their perspectives on SRL knowledge and its use in classrooms. Recognition of the features of belief systems, both the range of beliefs and the maintenance of possibly inconsistent beliefs within a belief system, is suggested to provide a productive perspective for seeking to further understand the puzzling state of knowledge and use of knowledge about SRL in classrooms.

In regard to SRL, we see that two related but different sets of beliefs can be expected to be influential (Vosniadou et al. 2017). We term these beliefs about SRL and beliefs related to SRL. In this paper, we focus on beliefs about SRL, recognising that the beliefs related to SRL can also be expected to be influential in student and teacher behaviour. These related beliefs include beliefs about intelligence and effort (e.g. Blackwell et al. 2007; Dweck and Leggett 1988), epistemic beliefs (e.g. Hofer 2002; Hofer and Pintrich 1997; Stathopoulou and Vosniadou 2007) and teaching (e.g. Fives and Buehl 2008; Hermans et al. 2008; Lombaerts et al. 2009). In the remaining sections of the paper, we focus on a range of beliefs specifically *about* SRL, summarised in Table 1.

Students' and Teachers' Beliefs About SRL

Knowledge of Learning and SRL Is Acquired Implicitly and So Does Not Need to Be Explicit

In both the Weinstein and Mayer (1986) and Pressley et al. (1989) frameworks, strong arguments were made for sustained, explicit teaching of learning strategies. Such teaching was expected to result in the development by teachers and students of detailed, comprehensive knowledge about learning, knowledge that was explicit and public, so that students and teachers would be able to articulate and jointly explore their knowledge about learning. In the account of explicit knowledge set out by Karmiloff-Smith (1986, 1992, 1994) and Cheung and Wong (2011), such knowledge of SRL would be available for conscious access and verbal report, having undergone a series of "representational redescriptions" from knowledge that was initially implicit.

However, it may be the case that knowledge about SRL is believed to be acquired implicitly, so that it is not necessary, or even misguided, to seek to make it explicit. Teachers may see self-regulation as important in their teaching and in students' learning (Chatzistamatiou and Dermitzaki 2013), but do not think it necessary to make it explicit. These teachers might view all knowledge about learning as being acquired "naturally", as a result of experience, so that it is not necessary to make explicit provision for it during teaching or study. Such a perspective does not seem to adequately represent the important influences of both implicit and explicit learning.

Table 1 Beliefs related to the self-regulation of learning discussed in this paper

Belief	Summary
1. Knowledge of learning and SRL is acquired implicitly and so does not need to be explicit.	Teachers might not understand the importance of making implicit knowledge about learning explicit.
2. Knowledge about learning and SRL is different in character to knowledge about curriculum content.	Teachers might believe that SRL is not a content domain about which they need to construct complex, deep, multilayered knowledge for generative learning.
3. Knowledge about learning and SRL is not used all that often.	Teachers might not understand the moment-by-moment interaction of task knowledge and SRL knowledge that takes place during learning.
4. Knowledge for teaching about learning and SRL needs to be practical, not theoretical.	Teachers might believe that the most important knowledge about SRL is derived from teaching practice, so that they undervalue the "principled" component of principled practical knowledge.
5. As a teacher I am not sure I can teach about SRL.	Teachers might believe that they do not know enough about SRL, or might not feel confident that they knew how to promote SRL in their teaching.
6. Leave the self-regulation to the students.	Some teachers might see that responsibility for SRL lies primarily with the student, not with the teacher.
7. Self-regulation is only for some students.	Some teachers might think that the promotion of SRL is of relevance only to specific groups within the student population and may limit the power of learning in other students.
8. Self-regulated learning is likely to be unteachable.	Some researchers and teachers might think that self-regulated learning is unteachable, so that it cannot, or need not, be the subject of explicit teaching.

Across a range of fields of learning, both implicit and explicit learning continue to be important throughout the course of development (Lichtman 2013; Midford and Kirsner 2005; Verneau et al. 2014) and may coexist in the same learning event (Ziori and Dienes 2012). To take knowledge about metacognition as an example, such knowledge is apparent in the early school years (Kuhn 1999; Alexander et al. 1995). However, as Efklides (2006) and Veenman (2017) have argued, such knowledge generated from early metacognitive experiences is subjective and non-conscious, and likely to be tacit and embedded within naïve theories. These characteristics do not, however, make such implicit knowledge unimportant for student achievement. This knowledge is the basis for later more complex metacognitive strategies, the explicit teaching of which has benefits for student achievement (Pintrich 2002; Rieser et al. 2016; Veenman 2017).

These findings point to the need to attend to both implicit and explicit learning throughout development. Early analyses of implicit learning (Reber 1989) pointed to the critical importance of implicit learning for providing the basis for subsequent knowledge acquisition. It is recognised in Reber's account, and in contemporary accounts of implicit learning (e.g. Eberhardt et al. 2017; Ziori and Dienes 2012), that during the course of development much knowledge, which would include knowledge about SRL, will be acquired implicitly and that it will be used successfully to guide later learning and problem solving. Since the research of Berry and Broadbent (1984), and more recently (Eberhardt et al. 2017), it has been clear that although we may consciously and successfully engage in a learning or problem solving task, the knowledge acquired in pursuit of that conscious goal need not be conscious. Rather it may be encapsulated and not easily accessible or reportable. This is of significance in teaching because it raises the possibility that students may not fully exploit important learning strategies that they have developed implicitly (bottom up), and could make better use of these strategies following explicit teaching of the strategies (top down) (Yang et al. 2017; Ziegler et al. 2018). This explicit teaching would require the teacher to make explicit their own SRL strategies that may well be used automatically.

As with other domains of knowledge, if there is to be in-depth discussion of SRL strategies as envisaged in frameworks like Weinstein and Mayer's (1986), then re-representation beyond the implicit level is necessary. In the representational redescription process described by Karmiloff-Smith (1994), detailed classroom discussion of knowledge about learning will enable the generation of knowledge that is conscious and available for verbal report. If teachers and students struggle to engage in such discussion, it might suggest that their knowledge is implicit and less available for flexible use during learning. This limitation seems likely to also obtain for teachers' theories of teaching (Thadani et al. 2015). To bring about change and to stimulate the generation of explicit knowledge about SRL, we suggest that the beliefs that knowledge about SRL need *only* be implicit, or that there is nothing to be gained by making it explicit, need to be challenged and examined. In addition, we see a need to consider a related, powerful belief of relevance here, one that involves a characterisation of knowledge about learning and about SRL in particular as having a status different from that of other domains of knowledge.

Knowledge About Learning and SRL Is Different in Character to Knowledge About Curriculum Content

In some discussions about SRL in schools and university, we ask students about a hobby and press them to articulate relationships between elements of the topic. Typically students

generate a long list of detailed and technical knowledge about the structure and procedures associated with the hobby. If this knowledge were to be mapped in a cognitive map, the map structure would be quite complex. If we then ask students how they acquired this very knowledge, a common response refers to reading of books and online sources. We then ask them to explain how the process of reading enables them to develop knowledge about the hobby. Most students, even undergraduate students, find it difficult to generate a detailed response to this question, so that the map we can make about their knowledge about learning through reading is typically quite simple. Askell-Williams and Lawson (2005) reported similar findings when they asked their pre-service teachers to explain why class discussions helped their learning, the students having indicated that discussions were the procedure that most helped their learning at university. Some of the students found the generation of an explanation very difficult and struggled to provide any explanation that went beyond a single layer in a concept map. Even though some explanations could be related to theories of SRL and were multidimensional, showing several layers of relationships in a concept map, these explanations did not typically involve use of the technical language about learning or SRL, but were more akin to what Bruner (1996) referred to as theories of "folk pedagogy", naïve theories that describe ideas about "what children's minds are like and how to help them to learn" (p. 46). Bruner makes the point that these folk theories are important and influential and need to be considered in pursuit of more complex knowledge. However, such folk theories are not at a level of development and explanatory coherence that would be expected of someone professionally involved in promotion of self-regulated learning. Such folk pedagogies of learning are less complex than they need to be and less prone to develop into complex knowledge that has a high degree of what Wittrock (1974) referred to as a "generative" character, one that supports the construction of strong internal and external connections and knowledge transfer (see also Fiorella and Mayer 2016). In each area of a school curriculum, a key objective is that students develop knowledge that has this generative character, so that students can use it to solve the problems during their school study and beyond. We expect high school students and undergraduate students will show evidence of such knowledge, and will be able to appropriately use the technical language and detailed procedures of their major curriculum areas of study. A folk theory of chemistry or literature would not be acceptable for such students. Rather the expectation, as set out by Bereiter and Scardamalia (2012), for students at both elementary and high school level, is for the development of theories that have explanatory coherence and power. Such a theory would "be internally consistent, consistent with provisionally accepted facts, and not generative of false predictions" (Bereiter & Scardamalia, 2012, p.163). If we expect students to have theories with explanatory coherence and generative power in Science and History, why should we not have similar expectations for the theories about learning and SRL held by students and teachers?

SRL is quite complex and is a sophisticated field with well-established theoretical frameworks. Pressley and Afflerbach (1995) identified more than 150 different general metacognitive activities that could be used during reading, not counting the more specific variations that could be used within each of the general categories. In a related taxonomy developed to describe metacognitive activities for problem solving in History and Physics, Meijer et al. (2006) identified 70 different classes of activities. These taxonomies focus mainly on the cognitive and metacognitive components of SRL and additional complexity would be present when affective and motivational components were included. Thus the corpus of knowledge related to SRL is large and complex.

Yet the research with school and university students noted above indicates that, for many, their SRL knowledge is not complex in either a quantitative or qualitative sense. Some students struggle to generate any simple explanations of how learning occurs, or to explain in a technical manner how the strategies they use act to assist their learning. Yet the same students are expected to explain complex chemical processes or explain differentiation rules in calculus. Although some students do have more qualitatively complex explanations for learning, they typically are not able to express their knowledge using the technical language of the field (Askell-Williams and Lawson 2005). This knowledge is not easily articulated, nor richly elaborated in complex, coherent structures that would support the generation of solutions to complex learning and teaching problems (Lawson and Askell-Williams 2012). Such knowledge is not generative or characteristic of the principled practical knowledge that Bereiter (2014) sees as necessary for teachers, knowledge that is "explanatorily coherent practical knowledge" (p. 5).

If development of complex knowledge about SRL is not happening, it may be that teachers see that this knowledge is of a different character from that of the curriculum areas in which they teach. Rawson et al. (2018) suggest that there is something of a "disconnect" between the ways that academics, teachers and students view academic learning and the way that they view knowledge and skill acquisition in other areas of their lives. One possibility is that teachers believe that knowledge about learning and SRL knowledge is not in itself a content domain about which you can construct complex, deep, multilayered knowledge.

Representation of knowledge about learning and SRL as being simple, and different to that of knowledge in other domains may also give strength to the belief that teaching is primarily a matter of knowledge transmission, thus ignoring the role of interpretation by the learner in knowledge acquisition. The strength of this transmissionist view of teaching is shown in a study with experienced Australian teachers of Geography (Lane 2015). Lane found that a majority of the teachers "believed that learning involved the accumulation of factual knowledge and did not, therefore, consider students' alternative conceptions when planning instruction" (p. 53). The views of these teachers do not give appropriate value to the constructive nature of learning that emphasises the key influence of activation of, and integration with, existing knowledge during the development of further knowledge. For the students of teachers in Lane's study who held such transmissionist views, the lack of discussion of their alternative existing conceptions might preclude the development of a coherent representation of the study topic. For such teachers, their own learning about their area of content knowledge and about learning may also not progress toward the development of coherent, generative knowledge. Such a possibility was illustrated in the study of science teachers by Arzi and White (2008) who followed teachers through 17 years of professional learning and found evidence of the maintenance across that time of fragmented, poorly integrated knowledge. For these teachers, a view of knowledge about learning and SRL as simple and unproblematic may have impacted negatively on both their learning and the learning of their science students.

We will return to the issue of the domain status of SRL knowledge later in this paper, but to move beyond the level of folk pedagogy and to increase the likelihood of maximising the potential benefit from explicit SRL strategy use, it would seem necessary to challenge the belief that knowledge about learning and SRL has a status different from other knowledge domains. It may also be important to address beliefs about the frequency of interaction between SRL knowledge and content knowledge and to acknowledge that, for some teachers, acquisition and use of more sophisticated knowledge of SRL could initially increase the cognitive load experienced during teaching.

Knowledge About Learning and SRL Is Not Used All That Often

If teachers do not engage in explicit teaching about SRL strategies, it may be that they believe that such knowledge is not used very frequently and so is not a high priority for use of precious lesson time that should be principally allocated to content knowledge. The priority that some teachers give to the teaching of content knowledge relative to strategy knowledge has emerged in several reports. In Cyprus, Ioannidou-Koutselini and Patsalidou (2015) showed that the discourse of principals and teachers was largely about lesson content. Dunlosky (2013) made a similar point, noting that the emphasis in school curriculum discussions was mostly about content, not study strategies. This stance on the part of teachers may arise because they have not considered in detail the momentary actions being undertaken by students during class activities. In many, if not in most, classroom lessons, it is very likely that a student will use many different SRL strategies. This could be occurring moment-to-moment in either a deliberate or automatic manner for setting goals, estimating a level of self-efficacy, perceiving and selecting relevant content, maintaining that content in working memory, elaborating on that content, integrating that with relevant prior knowledge, organising information for storage, checking on level of understanding, evaluating whether the goal has been achieved, making attributions of causality about the outcome, and so on. Consider the excerpt in Table 2 taken from a transcript of a Year 9 student's think-aloud protocol generated while attempting to solve a geometry problem that required the calculation of an angle in a triangle, one side of which formed a tangent to a circle (Lawson and Chinnappan 1994).

The excerpt is a brief snapshot of student learning activity, taken in about two minutes, yet it is likely to be typical of the actions of many students for much of the time when involved in an engaging lesson activity. In this excerpt, it is apparent that there was regular involvement of important cognitive and metacognitive events in interaction with relevant geometry knowledge. During these few minutes, the student identified and selected parts of the given information, related that to existing content knowledge, monitored the adequacy of problem-solving moves and evaluated the success of the chosen solution path as knowledge of geometry was also being activated and used. When she decided that she could not pursue the initially chosen path for solving the problem, she was confident enough to return to the problem statement and start again.

In this episode, we see instances of motivational, cognitive and metacognitive knowledge being used in frequent interaction with knowledge of geometry. This moment-by-moment interaction of task knowledge and SRL knowledge was described by Winne (1991) in his discussion of the constant activation of both task and SRL knowledge during learning. The necessary involvement of SRL knowledge is clear if the tasks facing a student in the moments after a teacher presents new information are considered. In those next moments of detailed task engagement, students must rapidly decide such things as how to approach the task in a motivational sense, what to select to pay attention to, how to encode the selected information and how to organise it in memory for later problem solving. Effective SRL strategy use does depend on having access to appropriate existing content knowledge, but the quality of the student's momentary SRL actions on that content knowledge will determine the quality of the future content knowledge that is stored for problem solving. If the student does not have ready access to good quality SRL knowledge and strategies, this will limit the quality of the task-related learning or problem solving. In the full transcript from Lawson and Chinnappan (1994), the student above judged that the first solution path was inadequate, returned to examination of the problem statement and then proceeded to develop a new and successful

Table 2 Think-aloud protocol excerpt

Talk	SRL activity
Student reads problem statement accurately	
I'll just draw down, the diagram, label all the points. A ...	Identifying and selecting given information
Can I draw this again?	Constructing diagram
Interviewer: Yes.	
C is the centre. That's not the right centre, but it is the centre.	Labelling, Evaluating
D, A, B, and E. Angle DCE has measure of 30 degrees, so this (DCE) is 30 degrees here, and I am given that AE, AE is tangent to the circle, centre C	Selecting, Reasoning using Content knowledge (CK)
So this CD is a radius and that (CDE) becomes 90 degrees, because a radius and tangent makes 90 degrees, and CB is a radius and CD is a radius, so they are equal.	Identifying, Labelling, Searching for and retrieving CK, Reasoning
AC is perpendicular to CE. So that's a right angled triangle there (ACE) and,	Retrieving CK, Reasoning
therefore, Angle ACD is equal to 60 degrees because angles in 90 degrees,	Reasoning, calculating
sorry a right angle is 90 degrees. (2–3 sec)	Checking, correcting
Um ... The radius is equal to 5 centimetres. Um ...	Identifying and selecting given information
This angle here (ADC) is equal to 90 degrees, so if I use cosine of 60 degrees.	Selecting, Retrieving CK, Choosing solution path
I can't use that.	Evaluating, rejecting the solution path
I'll read this again to see if I can find anything I missed.	Persisting, using problem-solving strategy

path to the solution of the problem. That student showed evidence of use of both good quality SRL knowledge and good quality task knowledge.

Knowledge for Teaching About Learning and SRL Needs to Be Practical, Not Theoretical

Earlier in this paper, research was noted in which the teacher participants did not frequently make provision for explicit teaching about SRL and SRL strategies. If pre-service and practising teachers believe that knowledge about learning and its regulation is acquired implicitly, or that such knowledge is different in nature from knowledge in other domains, or that it is used infrequently, this might be associated with a belief that the important knowledge about learning and SRL will be derived from practice, not from theory. Such a belief might well arise from teachers' professional situations on entry to the profession. Pajares (1993) argued that the situation of teachers in the early years of their professional preparation is different from that of other professionals. When teachers begin their professional education, Pajares suggested they "simply return to places of their past, complete with memories and preconceptions of days gone by, preconceptions that often remain largely unaffected by higher education" (p. 46). The pre-service teachers return to familiar schools and classrooms, where the activities of the occupants are also very familiar. In many other professions, the culture and routines of the profession are much less familiar to new entrants. In Pajares' words, prospective teachers are "insiders" returning to a very familiar environment.

For Woolfolk-Hoy and Murphy (2001), the preconceptions, the beliefs, carried into the school and classroom should be expected to be powerful influences on future teaching actions. If these pre-existing beliefs did not include representations of learning as a domain about which a complex body of knowledge needs to be acquired, or a topic for regular classroom discussion, then such beliefs could stand in the way when alternative representations of

learning, such as learning about learning as a self-regulated activity, were presented. It is not surprising therefore that prospective teachers often value practically based over theoretical knowledge (Bråten and Ferguson 2015). If they see themselves as insiders in the school situation then the knowledge generated, and the beliefs espoused, within the school might have a higher valence than those presented in a university class. This outcome was described in the research with teachers by Erickson et al. (2005), the researchers being confronted by a "discomfort many teachers feel with the idea of theory, which is often a hangover from the perceived irrelevance of parts of their teacher preparation programmes" (p. 791). In the language of social-identity theory (Nesdale 2007), with regard to knowledge about teaching and learning, the pre-service teachers are likely to see their school teacher supervisors as their in-group colleagues and their university lecturers as more of an out-group. If this were so, the beliefs about learning of the school supervisors would be predicted to have higher valence for the pre-service teachers, and this would represent a significant challenge for the teacher educator advancing alternative views about SRL.

As a Teacher I Am Not Sure I Can Teach About SRL

A belief related to SRL that needs to be considered relevant is the teachers' confidence in their capabilities to instruct students about SRL. Two related influences might be at play here, teacher judgements about the state of their knowledge and their levels of self-efficacy. Perry et al. (2008) found that while teachers in their study viewed the promotion of SRL positively, they did not feel confident that they knew how to do that promotion. This suggests that teachers' self-efficacy beliefs about their capabilities to undertake SRL promotion will also be an important area for further investigation. In a study by Bandura (1997), teachers reported lower levels of self-efficacy for influencing students' academic performance across the years of schooling and it seems likely that self-efficacy for promotion of SRL will follow that same course (Perry et al. 2008). Teachers' reports of strategies for improving students SRL in mathematics have been shown to be predicted by their self-efficacy beliefs (Chatzistamatiou et al. 2014). In related research, Dignath-van Ewijk (2016) found that, along with elementary teachers' beliefs about the promotion of SRL, their self-efficacy for stimulating SRL was the strongest predictor of their self-reported SRL behaviour, stronger than their knowledge about SRL. In that study, the more the teachers saw themselves as able to support SRL activity in students, the more they reported stimulating SRL in their lessons.

When teachers' beliefs about their self-efficacy for teaching about SRL are investigated, it would also be sensible to consider students' beliefs about their self-efficacy for regulating their learning. Caprara et al. (2008) have reported a progressive decline in students' level of self-efficacy for self-regulation of learning that parallels the lack of growth in students' reports of their use of SRL strategies across the secondary school years noted earlier in this paper. These reports remind us that teacher and student efficacy beliefs should both be considered in changing their behaviour with respect to the promotion and use of strategies for the self-regulation of learning in class lessons.

Leave the Self-Regulation to the Students

In their study with Dutch elementary school teachers, Dignath-van Ewijk and Van der Werf (2012) found a pattern of responses to questions on SRL and its promotion that may also be influential in the belief systems of teachers more generally. These teachers rated both

constructivist views of learning and SRL positively. However, in their responses to questions about SRL, most reported a view that favoured giving students autonomy to undertake their learning, rather than seeing that it was a responsibility of the teacher to teach explicitly about SRL. Some teachers might adopt a literal interpretation of the idea of *self*-regulation and see that responsibility for SRL lies with the student.

Such a perspective could be reinforced by consideration of the teacher's situation in classroom teaching involving sizeable groups of students. Clearly, the teacher cannot sustain equally detailed interaction with each student in the group during a lesson. Indeed, observational studies of elementary classrooms (Black 2004; Galton and Pell 2012) make it clear that in many classes students must work mostly on their own and so must teach themselves: "Although they sit in groups, for nearly 70% of the time they work on their own." (Galton and Pell 2012, p. 29). However, recognition of this high level of responsibility for learning being shouldered by the students makes it imperative that they know about, and can use, effective strategies for regulating their learning. This implies that the teacher must also accept a level of responsibility for helping students to develop good quality SRL knowledge, just as they do for curriculum knowledge. As argued earlier, leaving students with knowledge about SRL that is largely implicit may handicap their learning. Part of the teaching task for teachers will be to explicitly address the belief systems of their students about SRL, for, as Calderhead (1991) has argued, students may approach their learning with the belief that the responsibility for learning rests with the teacher.

Self-Regulation Is Only for Some Students

Some teachers hold beliefs about individual differences among students that also have implications for the promotion of SRL. Peeters et al. (2016) reported that in their study of SRL promotion there were a group of teachers who regarded the promotion of SRL as being of relevance only to high achieving students. Associated with that view was one that that lower performing students needed to give priority to mastering the relevant content knowledge, rather than to the use of specific learning strategies. Waeytens et al. (2002) observed a related belief about the importance of learning to learn that lead to different treatment of individual differences in students to that noted by Peeters et al. (2016). In the Waeytens et al. study, teachers who espoused a "narrow" conception about the importance of learning to learn saw the provision of tips on learning strategies to be most important for younger and less able students. The differing conclusions arrived at in these studies draws attention to the need to investigate the influence of beliefs related to a range of individual variables on knowledge and use of SRL strategies (Karlen et al. 2014).

Self-Regulated Learning Is Likely to Be Unteachable

The preceding discussion points to a range of different beliefs that are predicted to be linked to the level of promotion of SRL strategies by teachers and the level of use of these strategies by students. Despite the likelihood that each of these beliefs could be linked to low levels of promotion and use, in the associated research it is either assumed or stated explicitly that the teaching of SRL strategies is both possible and desirable. There is, however, a belief held by some researchers about the teachability of SRL that takes a contrary view. Sweller and Paas

([2017](#)) put this position most clearly: "Self-regulated learning is likely to be a biologically primary skill and so unteachable" (p. 88).

The distinction between biologically primary and biologically secondary knowledge forms part of Geary's evolutionary theory of educational psychology (Geary [2008](#); Geary [2012](#); Geary and Berch [2016](#)). In this theory, biologically primary knowledge is knowledge that humans have evolved to acquire unconsciously and without the need for teaching. In contrast, biologically secondary knowledge does not have this evolutionary advantage and so needs to be the subject of instruction. Within this theory, biologically secondary knowledge, such as knowledge of how to read, includes most of the knowledge included in school curricula: "Secondary knowledge is acquired consciously, with active mental effort and is facilitated by explicit instruction." (Tricot and Sweller [2014](#), p. 267). For Tricot and Sweller, this secondary knowledge is domain-specific knowledge, the acquisition of which provided a major reason for the development of school systems. Acquisition of domain-specific knowledge is critical for school performance and is suggested by Tricot and Sweller as the major component of expertise.

Clearly this evolutionary perspective raises important questions about learning that have implications for research and for classroom practice, especially for teaching about SRL. The recent discussions of evolutionary educational psychology have set formidable challenges both for its proponents and for its critics. Detailed discussion of these challenges is beyond the scope of this paper and we will limit our comments to two issues that point to the need to see these challenges as open questions.

The first of these concerns expertise. For Tricot and Sweller ([2014](#)), domain-specific knowledge is the dominant factor in the development of expertise in fields such as chess, with no influence in expertise being allocated to more general, domain-general knowledge. However, Lane and Chang ([2018](#)) report findings that show the influence of both domain-specific pattern recognition and high-level processing on chess memory. These authors found that fluid intelligence, a more general processing skill, was strongly related to chess memory, suggesting that "It is likely that higher fluid intelligence increases the ability to benefit from high-level processing more than it increases the ability to benefit from the automatic recognition of familiar patterns" (p. 345). These findings suggest that within the domain of chess knowledge, there is the possibility of strategic interaction between more domain-general processes and domain-specific processes.

The possibility of strategic interactions with what we might have seen as more "fixed" elements of cognition is also raised in a recent discussion of the neural basis of automaticity. Servant et al. ([2018](#)) examined the electrophysical correlates of automatisation during massed and spaced practice. Their findings suggest that their participants were being strategic in their use of working memory and long-term memory. If they judged their long-term memory to be reliable, it seems that they chose not to represent items in working memory, though the authors do not argue that such choices are made with respect to representations in long-term memory. The point we take from this research is that the possibility of strategic interactions between general and specific components of cognition and among elements of cognitive architecture also needs to be given further consideration.

A second challenge raised by the evolutionary educational psychology view concerns the status of knowledge about learning as a domain. In earlier discussion, we referred to this knowledge as a domain of knowledge about learning. Of concern here is whether it is reasonable to classify this knowledge as constituting its own domain of knowledge.

In considering this proposition, one of the difficulties that arises is the status of the definition of a domain of knowledge. It is quite common for the definition to be assumed to be agreed upon, so that "fields" of knowledge such as history, or science, or reading are labelled as domains. Although the definition of domain has not received a lot of attention, there are relevant analyses that have been set out by writers such as Hirschfield and Gelman (Hirschfeld and Gelman 1994) and Hacking (2001). In Hirschfeld and Gelman's definition:

> A domain is a body of knowledge that identifies and interprets a class of phenomena assumed to share certain properties and to be of a general type. A domain functions as a stable response to a set of recurring and complex problems faced by the organism. This response involves difficult-to-access perceptual, encoding, retrieval, and inferential processes dedicated to that solution. (p. 21)

The domain acts as "guide to partitioning the world" and as an "explanatory frame" (p. 21). Although Hacking does not agree with all of Hirschfield and Gelman's analysis, he extends their analysis, describing a domain as also encompassing a "set of skills and abilities" related to the body of knowledge, including declarative and procedural knowledge components, and argues that the domain acts "as a device that enables one to exercise these skills and abilities" (p. 510).

It seems reasonable to consider the possibility that the body of knowledge about learning, including knowledge about SRL, does refer to distinctive phenomena that share properties and encompass declarative and procedural knowledge and skills and abilities. This body of knowledge also provides a set of explanatory frames that enable analysis of the phenomenon of learning, analysis of the complex problems faced by learners. In this sense, we see that there is at least a reasonable basis for regarding the body of knowledge that is associated with the phenomenon of learning as a domain of knowledge. If the arguments about the interaction of domain-specific and general knowledge processes, and about the domain status of knowledge of learning have validity, then we see reason to give further consideration to the belief that SRL is unteachable. If knowledge of learning and its regulation is regarded as a domain, then the very large body of evidence generated by SRL intervention studies that show positive impacts supports the view that self-regulation of learning can be taught. In making this argument, we are not arguing against an evolutionary perspective per se, but that the processes of self-regulation seem to be well represented toward the variant pole of the continuum of cognitive mechanisms described by Geary and Berch (2016) in their account of evolutionary theory, rather than all being seen as unteachable. An evolutionary perspective would seem to predict that the impact of teaching on all cognitive mechanisms would also be represented along a low-high continuum.

Implications

In this paper we have been concerned to understand more about the puzzling lack of widespread promotion and use of strategies for regulating learning. We argue here that an area for further investigation of this puzzle should be the belief systems held by educators and researchers about learning and self-regulated learning. These are not trivial phenomena and further investigation and the generation of change are likely to pose serious challenges. The first three beliefs imply that knowledge about learning and SRL is simple or natural unlike knowledge in the subject areas and each could be the subject of further research. These beliefs

suggest lack of appreciation of the complex and constructive nature of learning and of the multiplicity of strategies that can be developed implicitly or explicitly by the learner or through explicit instruction by the teacher. Belief number 4 draws attention to the importance of further examination of the teaching context as an influence on teachers' belief systems. If the cultures of teaching in schools and universities do not value SRL strategies, their promotion and use will remain limited. As discussed below, this belief also has implications for researchers and the ways they may enable or inhibit the use of research findings. Belief number 5 highlights the need to further develop teachers' knowledge about self-regulated learning and their self-confidence in promoting it. For the remaining three beliefs, the available supporting evidence is not well-developed and each requires more careful examination. Indeed, for each there is current evidence that challenges the belief. There is, therefore, a reasonable basis for more detailed research related to this system of beliefs.

Consideration of how to address these beliefs makes clear that considerable degrees of conceptual change would be needed in teachers' belief systems about learning and self-regulated learning. Research on conceptual change can provide leads for understanding the nature of such beliefs and some of the instructional interventions that can be used to induce change (Amin and Levrini 2018; Sinatra and Taasoobshirazi 2018; Vosniadou and Skopeliti 2014; Vosniadou 2013). Conceptual change research also supports the view that teachers' beliefs are likely to be part of long-established and interrelated belief systems that have a level of coherence. Inducing change in such systems is predicted to be a slow process that will require teachers and students to understand that alternative views of the process of learning, such as the SRL view, can have greater explanatory power than their existing belief and, more importantly, that they have benefits for students' achievement that justify changes in teacher and student practice.

At present, it seems that many teachers are not convinced of such benefits. In a professional development programme that focused in detail on SRL strategies, Nibali (2017) reported that although teachers saw SRL as important for student learning they did not think they could actually teach it because of lack of time and resources. We suggest here that adherence to the beliefs that we have described is one of the reasons why teachers are not convinced of the benefits of promoting self-regulated learning in their classrooms. The first step toward producing some conceptual change learning is to bring these beliefs to light and make them the point of discussion in teacher education and professional development programmes so that teachers will become aware of them and of the influence they exert on their practices.

The classical instructional strategy used to create awareness that existing beliefs might not be adequate is to use dissonance producing instructional strategies such as cognitive conflict (Posner et al. 1982). Cognitive conflict works by asking the participants to provide solutions to a given problem or situation and then to present contradictory evidence designed to produce dissatisfaction and doubt about certain solutions. While some researchers are critical of using cognitive conflict (Smith et al. 1993-1994), most would argue that mild cognitive conflict can be helpful in promoting discussions that can lead to deeper understanding of the issues discussed (e.g. Hatano and Inagaki 2003). Cognitive conflict in itself is not adequate however to produce change. Practising and pre-service teachers must also be presented with explicit and persuasive information about self-regulated learning that will convince them of its benefits, most importantly for student achievement. In addition, it would be relevant to explore the affective status accorded to these beliefs by teachers since that is likely to influence the level of effort they might invest in pursuit of change (Efklides et al. 2018).

Pre-service teacher preparation courses are a critical site for improving knowledge and use of SRL strategies. Twenty years ago, Hamman (1998) recommended that pre-service teacher education programmes give detailed attention to SRL strategies, to help students identify their use of these strategies and to see how explicit use of the strategies could be included in class lessons. Perry et al. (2015a, b) also argue that SRL-focussed coursework is needed with field experiences and extensive mentorship from experienced teachers. The findings of research with pre-service teachers reviewed in this paper imply that it would be of benefit for pre-service teachers if Hamman's and Perry's recommendations were followed. It must be recognised, however, that attention to SRL strategies in pre-service teachers' coursework is unlikely to be sufficient to bring about change in classroom practice, without addressing the potential negative impact of implicit beliefs such as belief 5. The challenge for educators of pre-service teachers is to help these teachers develop and value their knowledge of SRL so that it has the character of Bereiter's (2014) principled practical knowledge.

Promotion of SRL at the level of school leadership, and system leadership, is also a likely issue for research. New teachers can still confront the view that "theoretical" knowledge is not of practical benefit in the school classroom. One way to increase the level of change toward more explicit SRL promotion could be for researchers and professional learning staff to work more with school leaders and whole school groups. The practices adopted in the research of Perry et al. (2015a, b) and Gore (2014) provide examples of how work at the whole school level can be effective. The need for such extended work at school level should remind researchers that findings from research still need to be translated for classroom use and more widespread adoption (Vanderlinde and Braak 2010). Vanderlinde and van Braak argue that effective translation involves attention to the ways in which research findings are expressed and to direct engagement with teachers about the practical significance of those findings. Spoth et al. (2013) also see that effective translation could involve researchers in sustained work with the practitioner in designing and implementing ways to enact changes in practice in the classroom. Researcher modelling of the full range of SRL strategy use for teachers could be linked to teacher modelling for students. This would be one way to help teachers overcome the lack of time and resources noted as an impediment to change in Nibali's (2017) study.

We see that the beliefs related to the frequency of use of knowledge about SRL strategies and the effects of strategy use on achievement also have implications for curriculum designers and for research on curriculum design. Contemporary curriculum designers for both schools and universities can easily crowd a curriculum with an amount of content that precludes serious consideration of the need to help students develop better quality knowledge about SRL that will, in turn, assist them to develop more powerful curriculum knowledge. There needs to be provision, and time, in a curriculum, to enable teachers and students to give explicit and sustained attention to the development of good quality knowledge about learning. The time needed for such attention needs to be a major feature of curriculum design.

A final group that might be the focus of future attention is students. The student has agency in *self*-regulation. It is the student who is responsible for the management of learning most of the time in class lessons and study periods. School leaders, teachers and researchers would seem to have a shared responsibility to enable students to directly and publicly enter into discussions about SRL and to be acquainted with the findings of SRL research. In this discussion, another teaching task for the teachers will be to explicitly address students' beliefs about learning and teaching and more specifically the belief that the responsibility for their learning rests with the teacher (see Calderhead 1991). Working out how to do this would be an exciting area for future joint research with teachers and students.

We agree with Bjork et al. (2013) that effective regulation of learning rates as an "important survival tool". Explicit promotion of SRL is a key area for improved practice in teaching at all levels of education. We have argued that such explicit promotion is not enough if implicit beliefs of teachers and students' such as the ones discussed in this paper are not addressed. To ignore the need for challenging such unproductive beliefs and of providing explicit promotion of SRL as part of curriculum designs set for all levels of education seems to place an unnecessary brake on the process of building more powerful knowledge for student problem solving. If all students do not have access to suitable SRL strategies in their moment-to-moment learning, then it is likely that many will not achieve as well as they could if they had such access.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

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