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Beliefs about the self-regulation of learning predict cognitive and metacognitive strategies and academic performance in pre-service teachers

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Abstract
The research investigated relationships amongst beliefs about the self-regulation of learning (SRL), study strategies and academic performance in 366 pre-service teachers. A Beliefs about Learning and Teaching (BALT) Questionnaire was used to examine beliefs that were both consistent and inconsistent with SRL. The final model emerging from the structural equation analysis showed that beliefs consistent with SRL were positive predictors of the self-reported use of cognitive and metacognitive strategies, while beliefs inconsistent with SRL were negative predictors. The use of cognitive and metacognitive strategies was in turn a positive predictor of the pre-service teachers' academic performance. About 50% of the teachers simultaneously agreed with statements indicating beliefs consistent and inconsistent with SRL. We argue that the co-existence of beliefs consistent and inconsistent with SRL undermines the use of cognitive and metacognitive strategies in pre-service teachers, with negative effects on their academic performance. It is suggested that interventions to support teachers to promote metacognition and SRL can be more effective if they address preservice teachers' beliefs that are not consistent with SRL and especially beliefs in transmissive teaching.

Keywords Self-regulated learning · Pre-service teachers · Learning strategies · Cognitive strategies and metacognitive strategies · ICAP · Achievement

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Introduction

In discussing changing approaches to learning and its regulation, Zimmerman (2008) pointed out that an important shift occurred in relatively recent years in educational research and theory from considering student achievement as being associated with a fixed mental ability or being determined by the social environment and early experiences, to something that depends on students' own activity and regulation. Although there are a number of different theoretical approaches to self-regulated learning (Boekaerts 1997; Efklides 2011; Hadwin et al. 2011; Pintrich 2000; Winne 2011; Zimmerman 2008), they all agree that students play a proactive rather than a reactive role in the learning process and that they can improve their learning and academic performance through the selective and efficient use of strategies, especially cognitive and metacognitive strategies, that allow them to manage and control their learning.

Despite the importance of using effective cognitive and metacognitive strategies for student achievement, there is a growing body of research indicating that students do not activate the SRL skills necessary to manage their learning (e.g., Askell-Williams et al. 2012; de Bruin and van Merriënboer 2017; Karlen et al. 2014; Winne 2014; Zimmerman 2008). Related to this there is also research indicating that many teachers do not provide, or provide very little, explicit instruction designed to improve students' SRL skills and comprehension monitoring abilities (e.g., Bolhuis and Voeten 2004; Dignath-van Ewijk 2016; Griffin et al. 2012; Ioannidou-Koutselini and Patsalidou 2015; Kistner et al. 2010; Spruce and Bol 2015).

One of the main explanations offered to explain the lack of explicit SRL instruction in the classroom is that pre-service and in-service teachers do not know, do not value, and especially do not believe that it is of major importance to teach their students effective self-regulation skills (e.g., Dignath-van Ewijk 2016; Lawson et al. 2019; Lombaerts et al. 2009; Pajares 1992; Spruce and Bol 2015; Vosniadou 2020). Students' and especially teachers' beliefs about SRL is one key area that has been investigated in the attempt to understand and explain the lack of adequate promotion of SRL in schools.

The present research investigates relations between pre-service teachers' beliefs about the self- regulation of learning, their self-reported use of cognitive and metacognitive strategies and their academic performance. In the sections that follow we explain why we focus on pre-service teachers. We argue that pre-service teachers might have constructed beliefs about learning and teaching that are both consistent and inconsistent with SRL, and discuss how these opposing beliefs might influence their use of study strategies and how they might be related to their academic performance. We also discuss why this research is relevant for the promotion of SRL skills in the classroom.

Why study pre-service teachers?

We focus on pre-service teachers because it is likely that they might have inadequate knowledge of the strategies that can support their learning (Bjork et al. 2013; Glogger-Frey et al. 2018a). Researchers from different countries have pointed out that pre-service teachers have fragmentary and poorly organized knowledge about learning and about metacognitive strategies (Ohst et al. 2015), and that they find it difficult to explain how learning works and/or about how instruction can help students support their cognitive processing (Elen and Lowyck 1999; Lawson and Askell-Williams 2012; Woolfolk-Hoy and Tschannen-Moran 1999). Glogger-Frey et al. (2018b) found that half of the pre-service teachers in their study did not mention any strategies for comprehension. Research in Australia (Lawson and Askell-

Williams 2001; Vosniadou 2020) indicated that pre-service teachers reported using mostly low level cognitive strategies such as repetition and note-taking while making no reference to more sophisticated cognitive strategies such as elaboration and organization of information, or metacognitive strategies like monitoring and evaluation,

Another reason why we focus on pre-service teachers is because we believe, as many researchers have argued before us, that interventions to foster the promotion of self-regulated learning in the classroom can be most effective at the time when prospective teachers receive their initial training (McCombs and Marzano 1990; Moos and Ringdal 2012; Panadero 2017). These interventions can start by focusing on teaching pre-service teachers about how to be more effective learners themselves. By understanding how learning happens and how they can become more capable in managing and controlling their own learning, pre-service teachers can see the positive results of strategic learning on their own academic performance. Understanding the importance of self-regulated learning for their own academic performance is probably the best way to demonstrate to them the importance of promoting SRL in their students when they themselves become teachers. If pre-service teachers do not have good knowledge of, and do not use, effective strategies to monitor and regulate their own learning, it is doubtful that they will consider that it is important to teach their students about self-regulation and metacognition. As Vermunt and his colleagues have pointed out, there has been much concern about teachers' teaching practices and little interest in teachers' own study strategies (Endedijk et al. 2013).

Cognitive and metacognitive strategies in the context of SRL

SRL theories investigate and attempt to understand cognitive, metacognitive, as well as motivational and emotional aspects of learning. In the present research we focus on cognitive and metacognitive strategies. We consider cognitive strategies to be the activities learners use to help them select, maintain, and encode to-be-learned information, store it in long-term memory and retrieve it for later use. Cognitive strategies can range from relatively passive and non-reflective acts usually associated with maintenance rehearsal, such as repetition, reading aloud, highlighting and taking notes, to more active and constructive activities that involve the elaboration and organization of information in memory (Mayer and Wittrock 1996; Pintrich 1999; Weinstein and Mayer 1986). Strategies for the elaboration and organization of information include, amongst others, summarizing, paraphrasing, question asking and answering, self-explaining or explaining to others, as well as activities such as generative note-taking or the creation of tables, diagrams, and concept maps. Cognitive strategies, and especially those that require the elaboration and organization of information, help learners to better encode new information, connect it to prior knowledge and store it in long-term memory so that it can be easily retrieved and used in new situations.

Metacognitive strategies are considered to be the activities learners use to help them plan, monitor and evaluate their cognitive processes (e.g., Hofer et al. 1998; Schraw 2001; Zimmerman 2000). Planning strategies, such as skimming a text before reading it or doing a task analysis of a problem, can help prepare a problem-solving approach to learning. Evaluation strategies, such as self-testing, are important to ensure that learning has occurred. Monitoring strategies, such as self-questioning, help learners keep track of the comprehension process during learning and assess their level of understanding while listening to a lecture or reading a text. Monitoring strategies are of utmost importance as they can be used to inform learners when a breakdown of comprehension has occurred and help them find ways to repair

it. Some researchers have also investigated learners' metacognitive awareness or reflection, i.e., their knowledge about the state of their learning and of the most efficient strategies that can be used to monitor and repair it to achieve one's goals (Dignath and Büttner 2008; Schraw 1998; Veenman et al. 2006).

Relations between the use of cognitive and metacognitive strategies and student academic performance

There is a considerable body of research including literature reviews and meta-analyzes of intervention studies that has documented the beneficial impact of self-regulated learning (SRL) on student achievement (de Boer et al. 2013; de Bruijn-Smolders et al. 2016; Dignath and Büttner 2008; Dignath et al. 2008; Jansen et al. 2019; Sitzmann et al. 2009). Although not all strategies used by students have the same beneficial effects (Dunlosky et al. 2013; Dunlosky and Rawson 2012) there is strong evidence of beneficial influence on achievement of a range of cognitive and metacognitive strategies (Broadbent and Poon 2015; Chiu 1998; Chi and Wylie 2014; Destan and Roebers 2015; Dignath and Büttner 2008; Dunlosky et al. 2013; Haller et al. 1988; Hattie 2013; Hattie et al. 1996). Haller et al. (1988) were the first to do a meta-analysis of the effects of metacognitive strategy instruction. Their results, based on 20 studies, showed that interventions which included multiple metacognitive strategies were more effective in enhancing student performance in reading comprehension than those which focused on only a few metacognitive strategies. In a meta-analysis of 51 interventions to foster study skills for students ranging from kindergarten to adults, Hattie et al. (1996) found that interventions were most effective when fostering student activity and metacognitive awareness. In a meta-analysis of 74 interventions designed to promote SRL skills in primary and secondary school students, Dignath and Buttner (2008) found that, for secondary school students, effect sizes on academic performance were higher if the intervention was based on a metacognitive theoretical background, focused on metacognitive reflection, and promoted the use of cognitive strategies. Broadbent and Poon (2015) in a systematic review of 12 studies found that metacognition and critical thinking correlated positively with academic performance. In another systematic review, de Bruijn-Smolders et al. (2016) also found that metacognitive strategies were amongst those that related positively to learning outcomes. Other studies have also shown strong relationships between cognitive strategies, metacognition and achievement, especially in the area of mathematics (e.g., Altun and Erden 2013; Carr and Jessup 1997; Desoete et al. 2001; Kramarski and Zeichner 2001; Mevarech and Kramarski 2014; Volet 1991).

Relations between teachers' SRL beliefs and SRL practices

There is a vast literature on the relationship between pre-service and in-service teachers' beliefs and their practices (see the most recent reviews by Basturkmen 2012; Buehl and Beck 2015; Fives and Buehl 2012; Mansour 2009). Most researchers agree that this relationship is a reciprocal one and that beliefs and practices influence one another and may vary across individuals and contexts. In some cases, beliefs and practices may be at odds with each other. Teachers may vary in the extent of the congruence or incongruence between their beliefs and practices depending on the level of development and experience, on their knowledge, self-awareness and reflection. Incongruence between beliefs and practices may also happen due to external factors such as school or community culture, instructional resources, and classroom

factors. In this paper we argue that another possible reason that teachers may be at odds between their beliefs and practices may be because they are conflicted in their beliefs.

Research investigating teachers' beliefs about SRL have shown that these beliefs have a direct effect on the SRL strategies that teachers promote in the classroom, indeed more so than their self-reported knowledge about SRL (Dignath-van Ewijk 2016; Dignath-van Ewijk 2017; Lombaerts et al. 2009; Spruce and Bol 2015). However, some of this research also shows that the relationship between beliefs about SRL and teacher practices associated with SRL is not straightforward. Spruce and Bol (2015), for example, found that even though the teachers they observed might have had positive beliefs about SRL these beliefs were not necessarily associated with strong knowledge about SRL or with promotion of SRL in the classroom. This lack of a straightforward relationship between beliefs and teacher practice reinforces the need to further investigate teachers' beliefs, including the possibility that teachers may hold internally inconsistent beliefs.

In the studies by Dignath-van Ewijk (2016), Dignath-van Ewijk (2017), Lombaerts et al. (2009), and Spruce and Bol (2015) teachers' beliefs were assessed using the *Self-Regulated Learning Teacher Belief Scale* (SRLTB), developed by Lombaerts and his colleagues (Lombaerts et al. 2009). The SRLTB is a 10 item self-report scale that investigates whether teachers support the introduction of SRL in primary education. It includes items such as "self-regulated learning makes pupils evaluate their learning approach better", "… makes it easier to take into account pupils' experiences", and "… is practicable in primary education". Teachers who score high on this scale can be considered strong proponents of SRL.

An important limitation of the SRLTB is that it focuses only on beliefs that are consistent with the promotion of self-regulation in the classroom, ignoring the possibility that teachers might, at the same time, hold beliefs that are inconsistent with self-regulation theory. Central to our argument are two suppositions: (1) that it is more productive to examine beliefs not as isolated units but as forming elaborate 'belief systems', and (2) that it is likely that belief systems about learning and teaching and about SRL are not very cohesive and might include beliefs both consistent and inconsistent with SRL.

As we have argued in previous work (Vosniadou 2020), pre-service and in-service teachers' beliefs are best conceptualized as consisting not of isolated and discrete units but as forming complex and elaborate 'belief systems,' (see also Churchland and Churchland 2012; Darmawan et al. 2020; Fives and Buehl 2012; Lawson et al. 2019; Nisbett and Ross 1980; Pajares 1992). A belief system is defined as a dynamic structure that covers a given domain of knowledge and is used, often implicitly, to filter incoming information and influence action. Of concern here are teachers' *educational belief systems* and especially beliefs about learning and teaching and about SRL. These belief systems are constantly evolving as new information comes in, creating contradictions and inconsistencies in the process. As Lombaerts et al. (2009) have noted, belief systems are not necessarily cohesive – on the contrary, teachers "may hold contradictory beliefs making it difficult to determine how particular beliefs influence instruction" (p. 89) (see also Pajares 1992; Warfield et al. 2005).

The possibility that teachers' belief systems hold beliefs both consistent and inconsistent with SRL is supported by recent research indicating that teachers' working knowledge is contextualized and fragmented, as opposed to representing a single coherent personal theory (Glogger-Frey et al. 2018a; Maggioni and Parkinson 2008; Markauskaite and Goodyear 2014). Teachers who hold incompatible beliefs may not be fully aware of the incompatibility in their beliefs or of the possible misalignment between their beliefs and their practices. Such lack of awareness is suggested by the findings of Spruce and Bol (2015) as alluded to earlier. They

reported, for example, that many teachers who held positive beliefs about SRL, expressed genuine surprise during their interviews about the low SRL demand of their assessments (see also Artzt and Armour-Thomas 1998).

Consideration of the possibility that pre-service and in-service teachers' belief systems may not be cohesive points to the importance of finding ways to study the coherence of these belief systems as opposed to only investigating beliefs consistent with the promotion of SRL. It is also important to identify the specific beliefs that are not consistent with SRL, which might stand in the way of the promotion of SRL in the classroom (Lawson et al. 2019). For example, one such belief is that learning is something that cannot be taught. If people believe that some people are born better learners than others and that there is not much you can do about this, they are not going to be committed to teaching their students learning strategies. Similarly, a belief in the fixed nature of intelligence (Dweck and Leggett 1988) would mitigate the expected effects of the use of cognitive and metacognitive strategies in problem situations. Research by Thadani et al. (2015) also suggests that teachers who believe that teaching is a malleable skill are more likely to seek out opportunities to change their teaching, through for example, the promotion of strategies for the self-regulation of learning, compared to teachers who believe that teaching is a talent (see also Fives and Buehl 2012).

Another set of beliefs relevant to the promotion of SRL in the classroom concerns beliefs regarding the importance of the use of cognitive and metacognitive strategies during a lesson. The position put by Winne (1991) and by Vosniadou (2020) is that there is a very frequent interaction between content knowledge and strategic knowledge. As the learner is exposed to new information in a lesson, that information must be analyzed, elaborated, stored, and integrated with existing knowledge. As these activities are in operation, effective learners also need to be planning their strategic activities and monitoring and evaluating their levels of understanding. The belief in the necessity of the frequent use of SRL strategic knowledge stands in contrast to the observational data showing that in many classes the dominant concern of teachers is with the provision of content knowledge, to the exclusion of knowledge about strategies (Dunlosky et al. 2013; Ioannidou-Koutselini and Patsalidou 2015). In these examples we see the possibility of contrasting beliefs being related to very different classroom instructional practices by teachers.

Knowledge about pre-service and in-service teachers' alternative beliefs and/or internally inconsistent belief systems is important because it can lead to more effective and powerful SRL interventions. Belief systems affect teacher practices and are especially dangerous when they remain implicit and unspoken. In the present study we investigate beliefs that are both consistent and inconsistent with SRL in order to understand pre-service teachers' belief systems and examine their influence on their study strategies and their academic performance.

Relations between beliefs, SRL strategies and academic performance in pre-service teachers

As discussed earlier there is substantial research, including literature reviews and meta-analyses, that support the claim that teachers' beliefs influence the promotion of SRL strategies in the classroom and the academic performance of students in primary, secondary and tertiary education (de Boer et al. 2013; de Bruijn-Smolders et al. 2016; Dignath and Büttner 2008; Sitzmann et al. 2009). There is also a considerable body of research that investigates relations between students' epistemological or epistemic beliefs, their study strategies and their academic performance.

Epistemic or epistemological beliefs are beliefs about the nature, source, structure, and justification of knowledge (Hofer and Pintrich 1997; Muis 2007; Schommer 1990; Schommer et al. 1992). There is a great deal of research on the relationship between epistemic beliefs and student achievement, especially in mathematics (see Muis 2004 for a review of this literature). This research has shown that some 'unsophisticated' epistemic beliefs are related negatively to learning and/or student academic performance, while other 'more sophisticated' epistemic beliefs are positive predictors of student achievement. For example, Schoenfeld (1989) showed that students who reported higher grades had more sophisticated epistemic beliefs. Hofer and Pintrich (1997) argued that beliefs that mathematics is complex, changing and consists of interrelated concepts were significantly positively related with intrinsic motivation, self-efficacy, and self-regulation, as well as with course grades. Schommer et al. (1992) found that the belief in simple knowledge was negatively related to the comprehension of a mathematics text. Koller (2001) found that beliefs that knowledge is certain and simple had negative effects on student achievement, whereas beliefs about knowledge consistent with constructivism and relativism had positive effects on achievement.

A prominent explanation of why or how epistemic beliefs influence academic performance is that they are mediated by cognitive and metacognitive study strategies (Muis 2007; Schommer 1988). In other words, if students believe that knowledge consists of isolated facts, they might think that memorizing lists of facts is a good strategy for understanding. Or, if they believe that knowledge is certain and unchangeable, they might seek strategies aiming at single answers and simple and permanent solutions. Given that the memorization of lists of facts or the search for simple solutions are not good learning strategies, one would predict poor learning and academic outcomes in these students. The present study builds on existing research to examine how beliefs related to and about SRL might influence pre-service teachers' study strategies and academic performance.

The present research

We approached the present research from the lenses of the framework theory approach to conceptual change in science (Vosniadou 2013; Vosniadou and Skopeliti 2014), because this approach can explain why pre-service teachers may hold beliefs inconsistent with SRL or have internally inconsistent belief systems. Very briefly, the framework theory claims that starting in childhood, individuals construct initial belief systems that are based on their everyday experiences in the context of lay culture. These initial belief systems might contain explanations different from the scientific information to which students are later exposed to through instruction. In such cases, learning may require substantial conceptual changes. Such changes usually take a long time to accomplish and synthetic or internally inconsistent conceptions, otherwise known as misconceptions, might be formed in the process.

It is reasonable to assume that pre-service teachers' initial beliefs systems about learning and teaching at the start of their university education might be substantially different from current theories of learning and especially SRL. Support for this view comes from research findings showing that pre-service teachers are likely to be teacher-centered, focusing more on the importance of teacher talk and the provision of subject matter knowledge than on the teaching of strategies (Kramarski and Michalsky 2009; McCombs et al. 2008; Moos and Ringdal 2012; Pajares 1992). Such beliefs, which might have been formed based on the pre-service teachers' own experiences as students, are not

consistent with SRL theory and are likely to interfere in its understanding and implementation in the form of study strategies, or in the classroom. Indeed, despite the abundance of research showing that SRL practices are strongly related to student achievement, there continues to be a tendency even in practicing teachers to place the teacher rather than the student at the center of the learning process in the classroom. This is the case because changing from a teacher-centered approach to a learner-centered approach consistent with self-regulation theory is a complex process that requires considerable conceptual changes – i.e., changes in categorization (from teacher as super-ordinate category to student), in epistemology (knowledge as transmitted vs. knowledge as constructed) and in representations (from teacher-centered, individually-focused learning environments to student-centered, collaborative learning environments).These conceptual changes may take a long time to be fully accomplished, causing in the process a lack of coherence in belief systems in the form of the co-existence of opposing beliefs or the construction of synthetic models and other misconceptions (Vosniadou 2013).

Coming now to the relation between pre-service teachers' beliefs and their study strategies, we hypothesized, following the rationale described in the previous section regarding the relation between epistemic beliefs and study strategies in students, that pre-service teachers with beliefs consistent with SRL would be more likely to use cognitive and metacognitive strategies with positive effects on their academic performance, compared to those with belief systems that lacked coherence or contained beliefs inconsistent with SRL.

This hypothesis was investigated in prior research using a Beliefs about Learning and Teaching (BALT1) questionnaire (Vosniadou 2020). The BALT questionnaire included items that tested beliefs both consistent and inconsistent with the self-regulation of learning. The results confirmed that beliefs about learning and teaching inconsistent with SRL were negative predictors of beliefs in the importance of teaching students SRL strategies, while beliefs consistent with SRL were positive predictors of the importance of teaching students SRL strategies. SEM modeling and subsequent cluster analyzes also revealed that the participants' belief systems included sets of internally inconsistent beliefs.

In the present study, a modified BALT questionnaire was used to investigate additional beliefs inconsistent with self-regulation theory. Compared to BALT1, the modified questionnaire, BALT2, included items that further examined beliefs inconsistent with SRL, such as the belief that knowledge about learning is not used all that often and therefore is not necessary, and that people do not have control over their learning. Moreover, the present study investigated pre-service teachers' study strategies and achievement. Study strategies were investigated using two open questions which asked the pre-service teachers to list the strategies they use during learning and to select the strategy they thought most helpful from that list and to explain why. The pre-service teachers' grades were used as a measure of academic performance.

A conceptual model, shown in Fig. 1, describes the hypothesized relations a) amongst the various learning, teaching and SRL beliefs, b) amongst beliefs and learning strategies, and c) amongst learning strategies and academic performance.

In Fig. 1 above, complete lines indicate positive paths or correlations and dotted lines indicate negative paths. The term *relations* is used to denote how two or more beliefs are associated. Beliefs are treated as latent constructs, which are unobserved and inferred based on the participants' responses to the questionnaire items. The model specifies the hypothesized causal (asymmetrical) linear associations between two or more constructs as paths, and the non-causal (symmetrical) linear associations between two or more constructs as correlations.

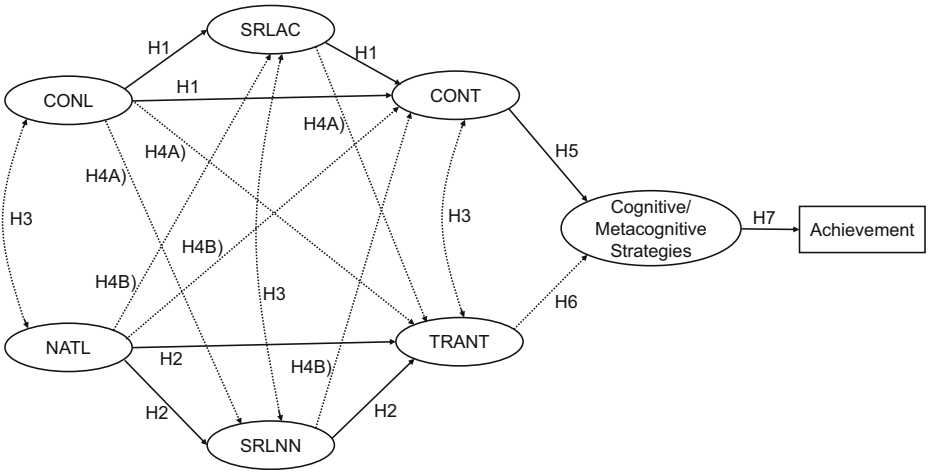

Fig. 1 Conceptual model showing the hypothesized relations between beliefs, cognitive and metacognitive strategies and achievement

Relations amongst beliefs

We hypothesized that the results would replicate the findings of our previous research regarding the relations between beliefs about learning and teaching and beliefs about the importance of teaching students learning strategies. The present research using BALT2 differed from previous research using BALT1 in the addition of a cluster of beliefs inconsistent with SRL, indicated in Fig. 1 under the label SRLNN (SRL Not Necessary).

More specifically, we hypothesized the following:

H1) Positive paths amongst beliefs in learning and teaching consistent with the self-regulation of learning. More specifically, we predicted a positive path leading from beliefs that learning is constructive (CONL), to beliefs that self-regulation is important for student achievement (SRLAC), to beliefs that it is important to teach students learning strategies (CONT).

H2) Positive paths amongst beliefs in learning and teaching inconsistent with the self-regulation of learning. More specifically, we predicted a positive path leading from beliefs in Natural learning (NATL), to beliefs that self-regulation is not necessary for student achievement (SRLNN), to beliefs that teaching consists mainly in the provision of subject-matter knowledge (TRANT).

H3) If the belief systems of the teachers were internally consistent, we hypothesized negative paths or correlations from beliefs consistent with SRL to beliefs inconsistent with SRL and the reverse. More specifically, we predicted the following negative paths:

(A) a negative path leading from all beliefs consistent with SRL to all beliefs inconsistent with SRL – i.e., from beliefs in the importance of teaching students learning strategies (CONL) to beliefs that self-regulation is not necessary (SRLNN); from CONL to beliefs that teaching consists mainly in the provision of subject-matter knowledge (TRANT); and from beliefs that self-regulation is important for student achievement (SRLAC) to TRANT,

(B) a negative path leading from beliefs inconsistent with SRL to beliefs consistent with SRL – i.e., from beliefs in natural learning (NATL) to SRLAC; from NATL to beliefs in the importance of teaching students learning strategies (CONT); and from beliefs that self-regulation is not necessary (SRLNN) to CONT.

And the following correlations:

(C) Negative correlations between consistent and inconsistent beliefs in learning, in SRL, and in teaching. More specifically, we predicted negative correlations between beliefs that learning is constructive (CONL) and that learning is natural (NATL); between beliefs that self-regulation is important for student achievement (SRLAC) and beliefs that self-regulation is not necessary (SRLNN); and between beliefs in constructive teaching (CONT) and beliefs that teaching consists mainly in the provision of subject-matter knowledge (TRANT).

H4) We hypothesized that deviations from the hypotheses described in H3 would imply lack of coherence in the pre-service teachers' belief systems.

Relations between beliefs and study strategies

We hypothesized that beliefs in the importance of teaching students learning strategies (CONT) will be positive predictors of the pre-service teachers' self-reported use of cognitive and metacognitive strategies (H5). On the contrary, beliefs in transmissive teaching (TRANT) were hypothesized to be negative predictors of the self-reported use of cognitive and metacognitive strategies (H6).

Relations between study strategies and academic performance

We hypothesized that the self-reported use of cognitive and metacognitive strategies would be a positive predictor of pre-service teachers' academic performance as measured by their grades (H7).

Method

Participants

The participants were 366 pre-service teachers, most of whom were female (67.5%) and aged less than 25 years (89%). They were all in their first year of study, enrolled in an introductory topic pertaining to general issues involved in Teaching and Education, in an initial teacher education program (Bachelor of Education degree) at an Australian University. At this point in their pre-service preparation they had not undertaken any courses focused on systematic study of self-regulated learning or metacognition. However, they had been introduced to theories of development and learning and had developed some understanding of motivation, learning strategies, teaching for learning transfer, assessment, and the need to develop self-directed learners able to carry out inquiry. The sample included pre-service teachers who were

planning to teach both in primary and high school. Approval for the research was granted by the university human research ethics committee. Students who consented to participate gave permission for accession to their student achievement records for the Subject Mark and GPA.

Materials

All participants completed the BALT2 questionnaire, which consisted of forty-four 6-point-scale items investigating beliefs about learning and teaching and about the self-regulation of learning. The questionnaire also included three demographic and background items, which asked the participants to provide information about their gender, age and educational major/minor. The scale items belonged to two general categories: items testing beliefs about learning and teaching consistent with respect to SRL theory, and items testing beliefs about learning and teaching inconsistent with respect to SRL theory. There were 20 items testing beliefs consistent with SRL theory: these included 10 items testing beliefs about *Constructive Learning*, five items testing the belief that SRL is important for student achievement (*SRL Achieve)*, and five items testing the belief that students should be taught strategies for learning (*Constructive Teaching)*. There were 24 items addressing beliefs inconsistent with SRL. These comprised 11 items testing beliefs that learning is quick and natural (*Natural Learning)*, 10 items testing the belief that SRL is not important for learning (*SRL Not Necessary)*, and three items testing the belief that teaching involves mainly the provision of subject knowledge (*Transmissive Teaching)*.

After completing the BALT2, the participants were given a definition of the term learning strategies: *'Learning strategies' is a term referring to the processes and actions that can be used to help us learn'* and were asked to answer the following two open-ended prompts:

(1) *'List all the learning strategies that you use while you are studying',*
(2) *From your list above, pick one strategy that you use and you think is important for your learning. Using your knowledge about learning explain why use of this strategy helps you learn (use technical language, if you can)'.*

Finally, academic performance was measured using the pre-service teachers' grade point average (GPA) and marks in the 1st Year Education topic '*Teaching and Educational Contexts*' (EDUC1120) (Subject Mark).

Scoring of the open questions

For the purposes of the present study we were interested in distinguishing responses to the two open questions that referred to cognitive and metacognitive strategies from other types of responses. In doing that two methods of scoring were used. Responses to Question 1, asking the participants to list as many study strategies as they could think of, were scored based on a theoretical framework consistent with SRL theory (Pintrich 1999, 2000; Zimmerman 2000). More specifically, we distinguished responses that referred to Cognition, Metacognition and Resource Management. There were very few responses that referred to motivational or affective strategies, so these were not taken into consideration. An inspection of the responses in the Cognition category revealed that they referred mainly to surface cognitive strategies, often known as rehearsal

strategies, such as, note-taking, reading, repetition, practice, and memorizing, as distinct from more sophisticated cognitive strategies involving the elaboration and organization of information. In the Metacognition category, the great majority of the responses referred to 'planning' without further elaboration, and very few responses referred to monitoring and evaluation or revealed some form of metacognitive reflection. In order to better distinguish surface or 'non-sophisticated strategies' from deeper or more 'sophisticated strategies', we decided to place responses that referred to organization and elaboration of information, monitoring and self-testing in the category 'sophisticated cognitive and metacognitive strategies' and the remaining cognitive strategies in the category 'non-sophisticated cognitive strategies'. Reference to global planning occurred frequently and was placed in a separate category. Final scoring categories were the following:

Resource Management strategies (Manage). These included management of the self (e.g. sleep, breaks, coffee, affective states, effort and attention), management of the learning environment (e.g. listening to music, quiet space, natural light, comfortable chair, study space), and management of social resources (e.g. group study, peer feedback, teacher questioning).
Global planning, without further elaboration (GLPlan). For example, plan for topic, prioritize, and plan for essay writing.
Non sophisticated cognitive strategies (NonSophCog). These included, recall, keywords and flashcards, reading, listening, observing, practice and repetition, and note taking.
Sophisticated cognitive and metacognitive strategies (SophCog). These included strategies referring for example, to the selection of important ideas, self-explanation, linking prior knowledge to newly acquired knowledge, monitoring understanding, and self-testing.

Two experimenters rated a sample of responses on each of the measures, discussed differences, and then completed an independent coding of sample transcripts. Assessment of inter-rater reliability resulted in 95% level of agreement between raters (Cohen's Kappa of 0.91). Final coding was then undertaken by one rater.

Responses to Question 2, which asked the participants to select what they considered to be the most important strategy, were analyzed using the Interactive, Constructive, Active, Passive (ICAP) theoretical framework developed by Chi and Wylie (2014). The ICAP theory distinguishes four cognitive engagement modes, labeled as Interactive, Constructive, Active, and Passive. Each mode of engagement corresponds to several different types of behaviors and to differentiable knowledge-change processes. Passive engagement is one where learners are not engaged in any overt behavior with learning materials indicating that learning is taking place (listening to a lecture) as opposed to active engagement, which requires that some action is taking place indicating manipulation of learning materials (such as note taking). Constructive engagement refers to actions that produce additional externalized inputs (such as constructing a concept map or providing self-explanation), while interactive engagement refers to constructive engagement that also involves interpersonal activity. Chi and Wylie have presented theoretical arguments and empirical research to support the argument that Active engagement produces better learning outcomes than Passive engagement; that Constructive engagement is better than Active, and that Interactive engagement produces the best learning outcomes. A summary of the ICAP-inspired scoring used in the present research is shown in Table 1, with examples taken from the strategies mentioned by the participants.

Two researchers scored 80 participant responses and compared ratings to assess inter-rater agreement. There was 75% agreement for ICAP scores ($\kappa = 0.694$).

Statistical procedures

The analysis of the results started with the development and testing of a measurement model, which included all factors related to the two general categories – namely, beliefs about learning and teaching consistent with respect to SRL theory and beliefs about learning and teaching inconsistent with respect to SRL theory. Even though these constructs and their respective items have been evaluated and validated, as part of a bigger instrument (Darmawan et al. 2020), a confirmatory factor analytical approach was used to reconfirm the extent to which items included in this study reflected the six factors used to capture pre-service teachers' beliefs on teaching and learning using the Mplus7 program. This model was estimated to provide assessment of the accuracy of the measurement theory. The results enabled assessment of how well the measurement model fitted the data. In the second stage of the analysis, a SEM model was developed, and the five measures related to strategies and GPA were added to the model.

Four model fit measures, which include Normed Chi-square, CFI, TLI, and RSMEA were used to test the fit of these models. For the normed or relative chi-square ($\chi 2/df$), although there is no consensus regarding an acceptable ratio for this statistic, recommendations range from as high as 5.0 (Wheaton et al. 1977) to as low as 2.0 (Tabachnick and Fidell 2007). The Comparative Fit Index (CFI) and the Tucker-Lewis index (TLI) were also reported. Values for these statistics range between 0.0 and 1.0 with values closer to 1.0 indicating good fit. A value greater than 0.90 is needed (Hu and Bentler 1999). In addition, the Root Mean Square Error of Approximation (RMSEA) was also used. A cut-off value close to 0.06 (Hu and Bentler 1999) or a stringent upper limit of 0.07 (Steiger 2007) seems to be the consensus amongst authorities in this area.

Table 1 A summary of the 'Interactive-Constructive-Active-Passive' (ICAP) scoring

Mode of engagement	Assigned Value	Description	Examples from pre-service teachers who participated in the research
Passive	1	Strategies that did not require overt behavior related to learning materials (i.e. resource management strategies, and strategies referring to general planning)	"Making sure I am in a quiet environment is crucial to my studying."
Active	2	Strategies referring to some manipulation of learning materials (i.e. taking notes, highlighting)	"Writing notes helps reinforce things that are taught in lectures and tutorials"
Constructive	3	Strategies referring to manipulation of learning materials producing new outcomes (i.e. making diagrams, flow charts, providing explanations)	"I work better when I have the points that I will be discussing in an essay on a map to see how I can specify and analyse if the content being used is appropriate."
Interactive	4	Strategies referring to constructive learning in interpersonal settings (i.e., collaborative concept map)	"Doing work with friends/groups; this strategy enables students to learn from each, build ones understanding and encouraged to look at different perspectives."

For the measurement model, once fit validity was established, additional components of construct validity and convergent validity, were evaluated. Convergent validity refers to the degree to which the items share a high proportion of variance in common. The size of factor loadings is one important consideration in this process. In the case of high convergent validity, high loadings on a factor would indicate that they converge on a common latent construct. At a minimum, all factor loadings should be statistically significant. For the magnitude of the standardized loading, the cut-off values proposed by Hair et al. (2006) was used. Factor loading of 0.4 and above are considered acceptable for the measurement model to be interpretable. Reliability is also an indicator of convergence validity. Coefficient alpha remains the most commonly applied estimate, although it may understate reliability.

Results

Open questions

Question 1

Table 2 provides descriptive statistics for the SRL strategies Manage, GLPlan, NonSophCog and SophCog.

Table 3 shows the percentage of pre-service teachers that mentioned using at least one strategy from each of the four strategy categories mentioned above. Of interest is the finding that over half of the pre-service teachers (55.1%) did not mention even one strategy from category 4 (organisation and elaboration cognitive strategies and metacognitive reflection).

Question 2

Responses to Question 2 were scored using the ICAP theoretical framework. The results are shown in Table 4. The category 'None' refers to non-responses or responses that were illegible and could not be scored. Passive were scored responses that referred to resource management or other responses not relevant to the content involved in studying. As can be seen 47.9% of the pre-service teachers' responses were categorized as 'None' or belonged to the Passive category, with just over 20% scored for the two higher categories of ICAP.

Pre-service teachers' measure of academic performance

Descriptive information about the pre-service teachers' GPA and course mark is shown below (Table 5).

Table 2 Descriptive statistics for SRL strategies

Strategy type	Mean	SD	Median
Resource management (Manage)	0.91	1.021	1
Global Planning (GLPlan)	0.36	0.564	0
Non-sophisticated cognitive (NonSophCog)	0.65	0.862	1
Sophisticated cognitive and metacognitive (SophCog)	1.50	1.352	0

Table 3 Percentage of students who indicated the use of at least one of the following SRL strategies

Strategy type	% of students
Resource management (Manage)	55.6
Global Planning (GLPlan)	32.1
Non-sophisticated cognitive (NonSophCog)	70.1
Sophisticated cognitive and metacognitive strategies (SophCog)	44.9

Subject mark

The distribution of pre-service teachers' marks for the 1st Year Education topic '*Teaching and Educational Contexts*'(EDUC1120) is presented in Fig. 2.

Measurement Model

From the initial results, three items reflecting the factor of Natural Learning were removed due to their low factor loadings. The three items were NatL01 ($l = 0.314$), "Successful students learn things quickly", NATL07 ($l = 0.168$), "The ability to learn is innate", and NATL10 ($l = 0.287$), "Learning is a talent". Three indicators of SRL Not Necessary were also removed for the same reason. They were SRLNN01 ($l = 0.348$), "In a lesson students only need to use one or two different learning strategies", SRLNN04 ($l = 0.306$), "The strategies we use for learning do not need to be part of our conscious knowledge", and SRLNN09 ($l = 0.362$), "It is possible to be a good learner without using learning strategies". The descriptive statistics, factor loadings and reliability coefficients for the factors for the remaining 44 items are presented in Table 6.

After removing items with low factor loadings, the measurement model fit the data well as indicated by the various fit indices. The CFI and TLI values were 0.903 and 0.891 respectively. The RMSEA value was 0.052 and the x^2 (842) = 1665.332. The x^2/df value was 1.977. All scales were of acceptable reliability with Cronbach's alpha coefficients greater than or close to 0.7.

The correlation coefficients among the six scales, the four SRL strategies, ICAP and GPA are presented in Table 7. As was expected the beliefs consistent with SRL (*Constructive Learning, Constructive Teaching*, and *SRL Achieve*) correlated positively with each other but negatively with beliefs inconsistent with SRL (*Natural Learning, Transmissive Teaching* and *SRL Not Necessary*). In general, ICAP, SophCog, and NonSophCog were positively correlated with beliefs consistent with SRL and negatively correlated with beliefs inconsistent with SRL. Manage and GLPlan, however, were not significantly correlated with either consistent or inconsistent beliefs, nor with GPA. GPA, as the outcome, was positively correlated with

Table 4 Frequency and percentage of pre-service teachers who reported strategies related to the ICAP method of scoring in Question 2

ICAP strategy	Frequency	%
None	45	12.3
Passive	130	35.6
Active	107	29.3
Constructive	66	18.1
Interactive	17	4.7

Table 5 Teachers' academic performance

	N	Minimum	Maximum	Mean	Std. Deviation
Mark for EDUC1120	365	0	94	75.02	10.949
Grade Point Average	365	.000	7.000	4.94173	1.126175
Valid N (listwise)	365				

beliefs consistent with SRL, ICAP, SophCog, and NonSophCog but negatively correlated with beliefs inconsistent with SRL. The distribution of pre-service teachers' GPA scores is presented in Fig. 3.

Relations between pre-service teachers' beliefs, study strategies and achievement: SEM

We investigated our hypotheses regarding the relations between pre-service teachers' beliefs, their study strategies and their achievement using structural equation modelling. Confirmatory rather than exploratory factor analysis was used in this study because the items were developed with strong theoretical grounding. The confirmatory factor analysis (CFA) employed allowed the researchers to test hypotheses about the relationship between observed variables and their underlying latent constructs. Since we used our knowledge of the theory and relevant research findings to postulate the relationship pattern a priori in the hypothesized model, the use of a CFA is justified.

A SEM model was estimated based on the relations between the pre-service teachers' beliefs, their learning strategies and their achievement as specified in the hypothesized model.

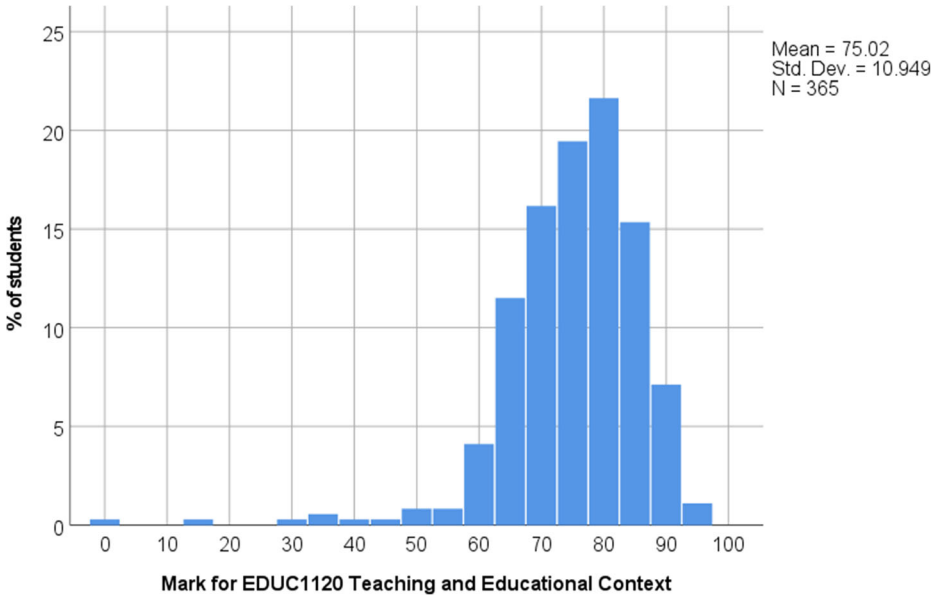

Fig. 2 The distribution of the pre-service teachers' marks for the topic "Teaching and Educational Contexts"

As measures of learning strategies we used scores for the four strategy types generated from responses to Question 1 described earlier (resource management, global planning, Non-sophisticated and sophisticated cognitive strategies) and in Question 2 (ICAP; where passive was scored as 1, active as 2, constructive as 3 and interactive as 4). As measures of achievement we used the pre-service teachers' GPA, and Subject Mark for the '*Teaching and Educational Contexts*' (EDUC1120) course. The SEM model (presented in Fig. 4) showed a relatively good fit to the data [$x^2(916) = 1924.48$, $p < 0.001$, $\frac{x^2}{df} = 2.10$, CFI = 0.884, TLI = 0.874, RMSEA = 0.055 with a 90% interval of 0.051 and 0.058].

In Fig. 4 above, dashed lines indicate non-significance ($p = 0.05$ level) and values alongside short arrows indicate residual variance estimates. In order to examine the relations amongst beliefs, strategies and achievement, regression and covariance estimates (along with standard error estimates) are provided in Table 8.

An additional SEM model was examined in which direct paths were added from CONL and SRAC (positive paths) and from NATL and SRLNN to cognitive and metacognitive strategies. The results showed a relatively good fit to the data [$x^2(858) = 1708.509$, $p < 0.001$, $\frac{x^2}{df} = 1.991$, CFI = 0.900, TLI = 0.890, RMSEA = 0.052 with a 90% interval of 0.049 and 0.056]. However, the results also indicated that the standardized path coefficients were above 1 (they should be below 1) indicating serious suppressor effects. This could be due to the relatively high correlations (strong paths) between CONL, SRLAC and CONT as well as between NATL, SRLNN and TRANT. The results did not change when direct paths to cognitive and metacognitive strategies were added only from SRAC and SRLNN. As a result, we concluded that the model described in Fig. 4 was the best model.

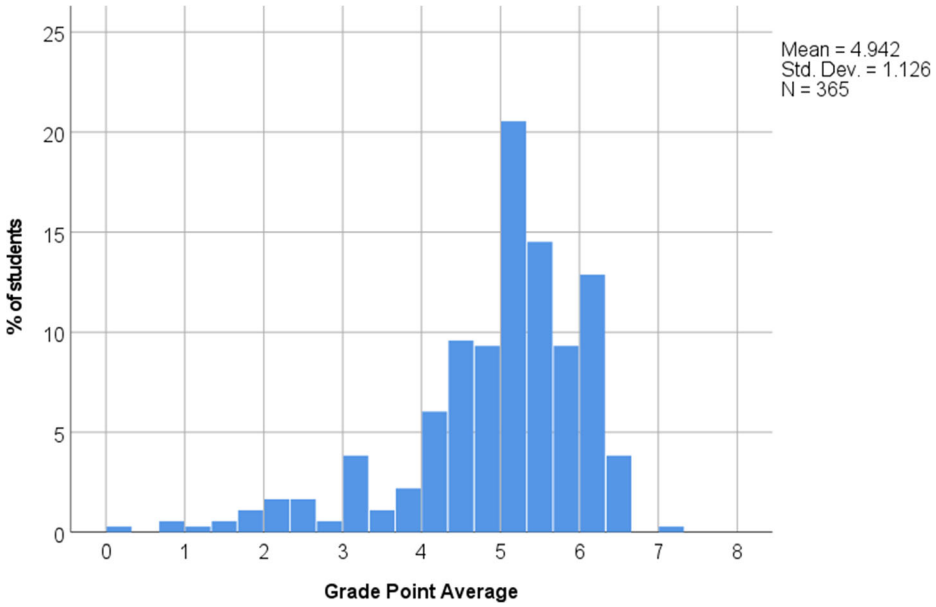

Fig. 3 The distribution of the pre-service teachers' GPA scores

Table 6 Descriptive statistics and measurement model results

Name	Description	n	mean	SD	Factor loading
Natural Learning (NATL)	Cronbach's Alpha=0.711				
NATL02	If students are going to be able to learn something it will make sense to them the first time they hear it	363	2.44	1.094	0.458
NATL03	Some people are good learners and you can't teach people how to learn	365	2.40	1.089	0.509
NATL04	It is a waste of time to try to understand something that does not make sense to you the first time you read it	364	1.76	0.833	0.786
NATL05	Effective learning is always quick	361	2.57	1.086	0.519
NATL06	The ability to learn can hardly be influenced by practice	362	2.44	1.070	0.569
NATL08	Children know all they need to know about learning when they are born	362	1.67	0.868	0.510
NATL09	Students who are smart must have been good learners	362	2.06	0.916	0.508
NATL11	You cannot be taught how to learn	363	2.14	0.844	0.621
Constructive Learning (CONL)	Cronbach's Alpha=0.804				
CONL01	Learning requires organization of information in memory	364	4.48	0.801	0.658
CONL02	When students activate their existing knowledge about a topic they learn more	362	4.62	0.746	0.572
CONL03	Students learn better if they organise what they learn in memory	364	4.26	0.829	0.704
CONL04	When information is well organised in memory it is more likely to be remembered	366	4.74	0.826	0.482
CONL05	The ability to recall information depends on how well it is organised in memory	363	4.36	0.803	0.628
CONL06	Learning involves the development of a meaningful knowledge structure	365	4.45	0.749	0.682
CONL07	Effective learning requires the ability to detect gaps in one's own understanding	364	4.75	0.698	0.744
CONL08	Students who can detect gaps in their knowledge learn more effectively	363	4.45	0.724	0.750
CONL09	If students ask themselves how well they have understood the material their learning improves	365	4.26	0.859	0.499
CONL10	Learning requires students to be able to reflect on how they learn	366	4.70	0.715	0.513
SRL Achieve (SRLAC)	Cronbach's Alpha=0.799				
SRLAC01	When students can learn to self-regulate their learning their achievement improves	360	4.51	0.700	0.740
SRLAC02	When student learn how to learn their performance improves	363	4.44	0.800	0.693
SRLAC03	When students have detailed strategies for how to remember key ideas they develop better understanding	363	4.50	0.777	0.707
SRLAC04	When students learn to regulate their learning in a lesson their understanding improves	365	4.44	0.679	0.609
SRLAC05	When students learn detailed strategies for learning they develop better understanding	362	4.33	0.826	0.783
SRL Not Necessary (SRLNN)	Cronbach's Alpha=0.751				
SRLNN02	Learning strategies are only needed when students meet a difficulty during learning	363	2.38	0.869	0.566
SRLNN03	Students don't need to be able to describe their learning strategies	364	3.43	1.011	0.463
SRLNN05		362	2.57	0.957	0.703

Table 6 (continued)

Name	Description	n	mean	SD	Factor loading
	As a student, being taught learning strategies explicitly does not help my learning				
SRLNN06	You do not need to understand the process of learning to be a good student	363	3.12	1.129	0.477
SRLNN07	Learning how to use learning strategies is a waste of time.	363	1.97	0.768	0.668
SRLNN08	Using learning strategies does not result in better learning	362	2.45	0.851	0.758
SRLNN10	You do not need learning strategies to develop good understanding	363	2.82	1.066	0.477
Constructive Teaching (CONT)	Cronbach's Alpha=0.695				
CONT01	An important task for teachers is to teach students strategies for learning	364	4.64	0.806	0.749
CONT02	Teachers should teach students ways to integrate new information with their existing knowledge	362	4.80	0.825	0.636
CONT03	When teachers create an environment where students can engage in learning, students learn more	366	5.40	0.686	0.486
CONT04	It is important for teachers to teach students how to monitor their understanding	362	4.45	0.744	0.613
CONT05	It is important for teachers to teach students ways to organise new information	365	4.72	0.737	0.604
Transmissive Teaching (TRANT)	Cronbach's Alpha=0.720				
TRANT01	The most important task of teachers consists of teaching subject knowledge	364	3.37	1.149	0.659
TRANT02	The main task of the teacher is to dispense information	365	3.08	1.110	0.781
TRANT03	The main goal of teaching is to increase the amount of knowledge in the students' memory	364	3.51	1.069	0.665

Relations amongst beliefs

The results confirmed the first set of hypotheses (H1) for the presence of positive paths amongst beliefs consistent with the self-regulation of learning as indicated by the solid black lines joining the relevant latent factors at the top of Fig. 4. Beliefs in Constructive Learning (CONL) were positive predictors of beliefs that SRL is important for student achievement (SRLAC), and both of them were significant positive predictors of beliefs in the importance of teaching students learning strategies (CONT).

The results also confirmed the second set of hypotheses (H2) regarding the presence of positive paths amongst beliefs in learning and teaching inconsistent with self-regulation theory, represented by the solid black lines in the lower left of Fig. 4. More specifically, the results confirmed that beliefs in Natural learning (NATL) were significant positive predictors of a) beliefs that self-regulation is not necessary for student achievement (SRLNN), and b) beliefs that teaching consists mainly in the provision of subject-matter knowledge (TRANT). The results also showed that SRLNN was a positive predictor of beliefs in transmissive teaching (TRANT), although this relation was not statistically significant.

The results did not confirm all the hypotheses regarding the presence of negative paths amongst beliefs consistent with SRL and beliefs inconsistent with SRL (H3A). Constructive

Table 7 Correlations

	01	02	03	04	05	06	07	08	09	10	11	12
(01) Natural Learning	1											
(02) Constructive Learning	−0.230*	1										
(03) SRL Achieve	−0.296*	0.814*	1									
(04) SRL Not Necessary	0.603*	−0.466*	−0.665*	1								
(05) Constructive Teaching	−0.431*	0.859*	0.886*	−0.645*	1							
(06) Transmissive Teaching	0.464*	0.170*	0.089	0.208*	0.012	1						
(07) ICAP	−0.022	0.118*	0.098	−0.129*	0.137*	−0.129*	1					
(08) SophCog	−0.169*	0.105	0.178*	−0.171*	0.078	−0.091	0.446*	1				
(09) NonSophCog	−0.001	0.106	0.072	−0.160*	0.006	−0.024	0.449*	0.334*	1			
(10) Manage	−0.077	−0.001	0.019	−0.067	0.091	−0.044	−0.071	−0.230*	−0.254*	1		
(11) GLPlan	0.045	−0.103	0.025	−0.075	−0.038	−0.092	−0.087	−0.145*	−0.291*	0.175*	1	
(12) GPA	−0.105	0.212*	0.160*	−0.182*	0.152*	−0.142*	0.191*	0.172*	0.155*	0.036	−0.072	1

* = $p < 0.05$

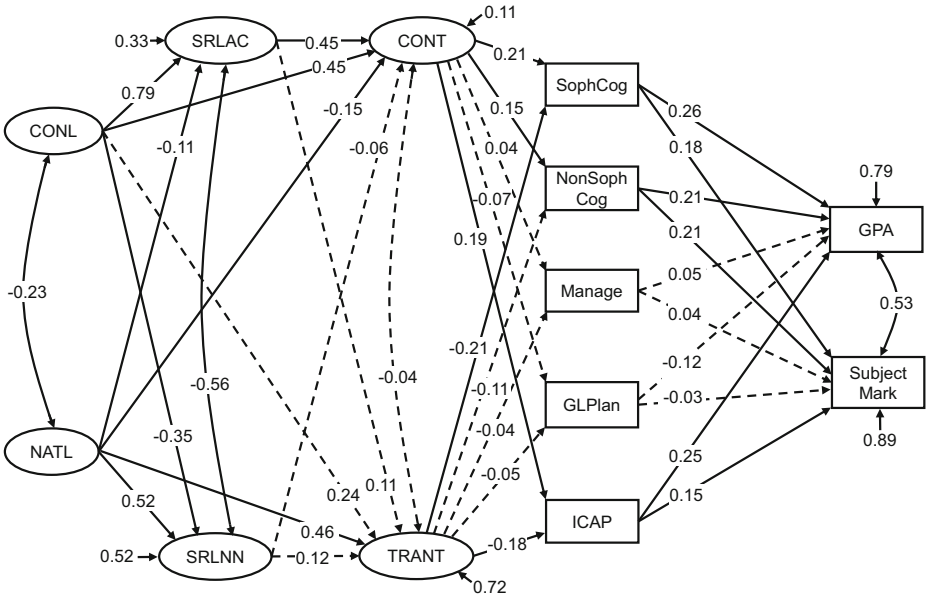

Fig. 4 Structural equation model showing the relations amongst the pre-service teachers' beliefs, study strategies and academic performance

learning (CONL) was a significant negative predictor of beliefs that SRL is not necessary (SRLNN), but not of beliefs in transmissive teaching (TRANT). On the contrary, CONL was a positive, but not statistically significant, predictor of TRANT. Also contrary to H3A, the belief that SRL is important for student achievement (SRLAC) was a positive (although not significant) predictor of TRANT, and not a negative one.

Beliefs inconsistent with SRL were negative predictors of beliefs consistent with SRL as predicted (H3B). More specifically, natural learning (NATL) was a significant negative predictor a) of beliefs in the importance of SRL for student achievement (SRLAC), and b) of beliefs in the importance of teaching SRL strategies (CONST). There was also a negative although not statistically significant path from beliefs that SRL is not necessary (SRLNN), to beliefs in the importance of teaching learning strategies (CONT).

The results also confirmed the presence of negative correlations between SRL consistent and SRL inconsistent beliefs (H3C). Constructive Learning (CONL) correlated negatively with Natural Learning (NATL), and beliefs in the importance of SRL for student achievement (SRLAC) correlated negatively with beliefs that SRL is not necessary (SRLNN). The correlation between beliefs in the importance of teaching strategies (CONST) and Transmissive teaching (TRANT), although negative, was not statistically significant, indicating the possible co-existence of these two beliefs in the pre-service teachers' minds.

The finding of direct positive paths from beliefs in constructive learning to transmissive teaching and from beliefs that SRL is important for student achievement to transmissive teaching implied the presence of possible co-existence of opposing beliefs in these areas (H4). In order to test this hypothesis composite scores were calculated for

Table 8 Structural equation model estimates

Hypothesis	Regression and covariance paths	Regression estimate (unstandardized)	Standard error (unstandardized)	Regression estimate (standardized)
H1	CONL to SRLAC	0.99**	0.13	0.79**
	CONL to CONT	0.57**	0.12	0.45**
	SRLAC to CONT	0.45**	0.12	0.45**
H2	NATL to SRLNN	0.70 **	0.12	0.52**
	NATL to TRANT	0.78**	0.18	0.46**
	SRLNN to TRANT	0.15	0.18	0.12
H4	CONL with NATL	−0.10**	0.03	−0.23**
	SRLAC with SRLNN	−0.17**	0.03	−0.56**
	CONT with TRANT	−0.01	0.04	−0.04
H4A)	CONL to SRLNN	−0.27**	0.05	−0.35**
	CONL to TRANT	0.24	0.14	0.24
	SRLAC to TRANT	0.09	0.16	0.11
H4B)	NATL to SRLAC	−0.24*	0.10	−0.11**
	NATL to CONT	−0.33*	0.15	−0.15*
	SRLNN to CONT	−0.09	0.15	−0.06
H5	CONT to SOPHCOG	0.20**	0.06	0.21**
	CONT to NONSOPHCOG	0.13*	0.06	0.15*
	CONT to MANAGE	0.03	0.05	0.04
	CONT to PLANNING	−0.06	0.06	−0.07
	CONT to ICAP	0.17**	0.05	0.19**
H6	TRANT to SOPHCOG	−0.25**	0.09	−0.21**
	TRANT to NONSOPHCOG	−0.13	0.07	−0.11
	TRANT to MANAGE	−0.05	0.07	−0.04
	TRANT to PLANNING	−0.06	0.09	−0.05
	TRANT to ICAP	−0.21**	0.07	−0.18**
H7	SOPHCOG to GPA	0.28**	0.08	0.26**
	NONSOPHCOG to GPA	0.23**	0.06	0.21**
	MANAGE to GPA	0.05	0.07	0.05
	PLANNING to GPA	−0.14	0.07	−0.12
	ICAP to GPA	0.27**	0.06	0.25**
	SOPHCOG to Subject Mark	1.86*	0.79	0.18*
	NONSOPHCOG to Subject Mark	2.26**	0.62	0.21**
	MANAGE to Subject Mark	0.41	0.63	0.04
	PLANNING to Subject Mark	−0.33	0.73	−0.03
	ICAP to Subject Mark	1.53**	0.56	0.15**

these sets of beliefs. As shown in Table 9, there was a high level of co-existence between (1) Transmissive Teaching and Constructive Learning (47.5% overlap), (2) Transmissive Teaching and SRL achieve (46%), and (3) Transmissive Teaching and Constructive Teaching (47%). Such levels of co-existence were not present between Natural Learning and Constructive Learning (1.6% overlap) or between SRL Achieve and SRL Negative (6.8% overlap).

Table 9 Co-existence of beliefs consistent and inconsistent with SRL

1.Transmissive Teaching vs Constructive Learning
• 98.4% of total Agree to Constructive Learning
• 52.5% of total Disagree to Transmissive Teaching
• 47.5% of total Agree to both
2.Transmissive Teaching vs SRL Achieve
• 95.9% of total Agree to SRL Achieve
• 52.5% of total Disagree to Transmissive Teaching
• 46.0% of total Agree to both
Transmissive Teaching vs Constructive Teaching
• 99.2% of total Agree to Constructive Teaching
• 52.5% of total Disagree to Transmissive Teaching
•47.3% of total Agree to both
Natural Learning Vs Constructive Learning
• 98.4% of total Agree to Constructive Learning
• 98.4% of total Disagree to Natural Learning
• 1.6% of total Agree to both
SRL Achieve vs SRL Negative
• 95.9% of total Agree to SRL Achieve
• 92.3% of total Disagree to SRL Negative
• 6.8% of total Agree to both

Relations between beliefs and study strategies

We hypothesized that beliefs in the importance of promoting SRL in the classroom (CONT) would be positive predictors of the pre-service teachers' self-reported use of cognitive and metacognitive strategies (H5). On the contrary, beliefs in transmissive teaching (TRANT) were hypothesized to be negative predictors of the self-reported use of cognitive and metacognitive strategies (H6). The results confirmed these hypotheses.

Relations between study strategies and achievement

We hypothesized that the use of cognitive and metacognitive strategies, including ICAP, would be positive predictors of academic performance (H7). The SEM results confirmed this hypothesis for both the non-sophisticated cognitive strategies and the more sophisticated cognitive and metacognitive strategies. This finding suggests that both of these types of identified strategies assist students in increasing the organization and usability of knowledge. The strategies that refered to the management of the environment or to global planning were not. This was the case both when GPA and Subject Mark were used to measure academic performance.

Discussion

The research reported in this paper investigated relations among pre-service teachers' SRL beliefs, self-reported study strategies, and academic performance. Overall, the results confirmed that the pre-service teachers' beliefs consistent with SRL were positive predictors of their self-reported use of cognitive and metacognitive strategies and that the self-reported use of cognitive and metacognitive strategies was a significant positive predictor of their academic

performance. These results are in agreement with prior research showing the positive effects of the use of cognitive and metacognitive strategies for student achievement (de Boer et al. 2013; de Bruijn-Smolders et al. 2016; Dignath and Büttner 2008; Dignath et al. 2008; Jansen et al. 2019; Sitzmann et al. 2009), and with research indicating that beliefs consistent with SRL are related to the use of SRL strategies (e.g., Dignath-van Ewijk 2016, 2017; Lombaerts et al. 2009).

One important innovation of the present research was the investigation of the coherence of pre-service teachers' beliefs about SRL. Adopting a conceptual change theoretical perspective guided by the framework theory approach (Vosniadou 2013), it was argued that it is likely that pre-service teachers might hold beliefs both consistent and inconsistent with SRL. Beliefs inconsistent with SRL, such as that learning is a natural ability and that it cannot be taught, or that the main task of teaching is the provision of subject matter knowledge, are known to be frequent in pre-service as well as in practicing teachers (e.g., Pajares 1992; McCombs et al. 2008; Kramarski and Michalsky 2009). It was argued that the presence of inconsistent or opposing beliefs in pre-service teachers might be related to the frequency of use of cognitive and metacognitive strategies. In what follows we will discuss the findings pertaining to these hypotheses in greater detail.

Beliefs inconsistent with SRL and their co-existence with beliefs consistent with SRL

The results provided partial support to the hypothesis regarding the presence of beliefs inconsistent with SRL. The pre-service teachers in our sample did not show high agreement with statements expressing the belief that learning is natural and that it cannot be taught. However, they agreed with some statements expressing the belief that SRL is not necessary for student achievement. For example, they agreed with statements such as, 'Students do not need to be able to describe their learning strategies" (mean agreement 3.43), and "You do not need to understand the process of learning to be a good student" (mean agreement 3.12). They also indicated agreement with statements indicating beliefs in transmissive teaching, such as "The most important task for teachers consists of teaching subject knowledge" (mean agreement 3.37) and that "The main goal of teaching is to increase the amount of knowledge is their students' memory" (mean agreement 3.51).

As expected, there was a high degree of relatedness amongst the consistent with SRL beliefs. Positive paths were obtained leading from beliefs in constructive learning to beliefs in the importance of SRL for student achievement and for teaching SRL strategies. Positive paths were also obtained amongst the inconsistent with SRL beliefs: beliefs that learning is natural predicted beliefs that SRL is not necessary for student achievement, which in turn predicted beliefs in transmissive teaching. These positive paths suggest that these beliefs are not unitary and isolated but form complex belief systems.

We hypothesized negative paths leading from consistent to inconsistent with SRL beliefs and the opposite. This hypothesis was confirmed in the case of the inconsistent with SRL beliefs, which were found to be negative predictors of beliefs consistent with SRL. However, contrary to our hypotheses, the beliefs consistent with SRL were found to be positive and not negative predictors of beliefs inconsistent with SRL. Beliefs in constructive learning and beliefs that SRL is important for student achievement were both positive predictors of transmissive teaching (although not statistically significant). These positive paths indicate the presence of belief incongruence.

Indeed, about half of the pre-service teachers in our sample who indicated high agreement with beliefs consistent with SRL, simultaneously believed that the most important task for teachers is the provision of subject matter knowledge. It is not clear if the teachers were aware of inconsistency in their beliefs or whether they had constructed some synthetic conceptions that removed the inconsistency. It is possible that for some teachers it might not seem inconsistent to believe that SRL is important for student achievement but that the promotion of SRL strategies in the classroom is not as important as the provision of subject knowledge. More research is needed using individual interviews to better understand exactly how pre-service teachers reason about these issues. Overall, these findings are consistent with the results of prior research indicating that teachers' intended practices are more oriented towards knowledge transmission approaches than their beliefs (Murray and MacDonald 1997; Trigwell and Prosser 1996; Norton et al. 2005).

Relations between pre-service teachers' beliefs and reported use of study strategies

The pre-service teachers' beliefs in the importance of teaching subject matter knowledge were found to be significant negative predictors of the reported use of sophisticated cognitive and metacognitive strategies and of ICAP. The presence of a direct negative causal relation between beliefs in transmissive teaching and the reported use of sophisticated cognitive and metacognitive strategies is an important new finding with implications for SRL interventions, especially in view of the high degree of agreement with this belief expressed by many of the pre-service teachers.

The results of the SEM model confirmed the hypothesis that beliefs consistent with SRL would be positive predictors of the reported use of cognitive and metacognitive strategies. There was a direct significant positive path from beliefs in the importance of teaching students learning strategies to the self-reported use of sophisticated cognitive and metacognitive strategies, non-sophisticated cognitive strategies, and ICAP. However, while almost all the pre-service teachers indicated agreement with beliefs consistent with SRL, about half of them simultaneously agreed that the most important task for teachers is the provision of subject matter knowledge.

Given the direct negative path from transmissive teaching to the self-reported use of sophisticated cognitive and metacognitive strategies and of ICAP, this finding implies that the co-existence of opposing beliefs with respect to SRL undermines the use of sophisticated cognitive and metacognitive strategies in pre-service teachers. This agrees with the finding that about 50% of the pre-service teachers in our sample did not make any reference to sophisticated cognitive and metacognitive strategies in their responses.

The belief in the importance of teaching subject-content appears to be the critical factor that influenced the use of cognitive and metacognitive strategies in the pre-service teachers in our sample. More research is needed to determine whether this result applies also to practicing teachers because it might be an important factor when trying to understand the lack of explicit teaching of learning strategies in the classroom by teachers who report having positive beliefs about the self-regulation of learning. It seems likely that there is also an involvement in teachers' decision making that relates to the pressure for them to 'cover' a crowded curriculum. Harding et al. (2017) found that the decision of teachers about the promotion of SRL was impacted by the limited time they saw as being available for addressing the multiple demands of classroom teaching. A positive view of SRL strategies may not be adequate to justify allocation of classroom time to their teaching. Such views of teaching need further investigation.

Relations between the reported use of study strategies and academic performance

The results of the SEM model showed that sophisticated cognitive and metacognitive strategies, non-sophisticated strategies, and ICAP were direct positive predictors of academic performance in the pre-service teachers. This result is consistent with existing research and provides further support to the arguments linking cognitive and metacognitive processing and academic performance (de Boer et al. 2013; Chi and Wylie 2014; de Bruijn-Smolders et al. 2016; Destan and Roebers 2015; Dignath and Büttner 2008; Dunlosky and Rawson 2012; Hattie et al. 1996; Hattie 2013).

The direct positive effect on academic performance was obtained both when strategy use was measured on the basis of responses to the second question and was coded using the ICAP theoretical framework, and when measured on the basis of responses to the first question and was coded using the SRL theoretical framework. In the case of the SRL scoring, the results showed that only the two categories of cognitive/metacognitive strategies – non-sophisticated cognitive and sophisticated cognitive – were positive predictors of the pre-service teachers' academic performance. The other categories were not. The ICAP scoring rewarded the use of strategies related to interactive and constructive modes of engagement (scored as 4 and 3 respectively) over active and passive modes of engagement (scored as 2 and 1 respectively), based on the Chi and Wylie (2014) theory. The strategies scored as interactive and constructive in this framework corresponded for the most part with the SRL category of sophisticated cognitive strategies for the organisation and elaboration of information and metacognitive strategies for the monitoring and evaluation of learning. Non-sophisticated cognitive strategies in the SRL framework corresponded to the active category in ICAP. As is shown in Table 6, ICAP correlated significantly with the SRL category of both non-sophisticated and sophisticated cognitive strategies, but not with strategies indicating the management of resources or unspecified planning.

The finding that the strategies that referred to the management of resources and general planning were not positive predictors of the pre-service teachers' academic performance points to areas for further research. Prior research has shown developmental differences in the relation between study strategies and academic performance. For example, Dignath and Büttner (2008) found that motivational strategies had a stronger effect on student achievement, compared to cognitive and metacognitive strategies, for primary school students but not for older students. Although resource management strategies can be expected to have potential to contribute to effective strategy use and higher achievement (e.g., Pintrich 2000), it seems likely that students may need to develop further knowledge about effective use of such strategies to gain the predicted benefits. A similar issue arises with respect to global planning. As noted earlier, planning is a key component of metacognition. But in the data reported here, the pre-service teachers' reports referred to global, unelaborated planning and did not provide evidence of detailed explicit knowledge of how planning activities can result in more effective knowledge construction. The character of such planning is also an important area for further research.

The finding that the self-reported use of both non-sophisticated cognitive and sophisticated cognitive and metacognitive strategies is a direct positive predictor of academic performance is noteworthy, especially in view of the fact that 55.1% of the pre-service teachers did not mention even one sophisticated cognitive and metacognitive strategy, and that 29.9% did not mention even one non-sophisticated cognitive strategy. This reinforces the need to provide interventions to improve pre-service teachers' explicit knowledge about, and use of key cognitive and metacognitive strategies, both in order to improve their own academic

performance during their studies and in order to increase the likelihood that they will promote these strategies in their classroom lessons.

Limitations, future directions, and implications for initial teacher education

The use of the pre-service teachers' study strategies was investigated in the present research with open questions. Open questions avoid many of the problems of self-reports that use forced-choice questionnaires requiring the participants to state their degree of agreement to a list of pre-determined strategies. More specifically, open questions avoid the problem of having the participants agree, because of social desirability issues, that they use strategies that they might not use at all or use very rarely. The use of short scales and single item questionnaires has been addressed and supported in the literature [See for example the Special Issue on this topic in the *Journal of Individual Differences, (2014, 35(4)*]. Nevertheless, future research using observations of pre-service teachers' study practices will strengthen the present results. Similarly, the use of interviews to complement the BALT questionnaire will provide further crucial information about pre-service teachers' beliefs and especially about the ways that pre-service teachers reconcile their seemingly opposing beliefs about teaching and learning and about SRL.

The present research involved a limited sample of pre-service teachers at the beginnings of their initial teacher education. Further studies are needed with larger samples of pre-service teachers, with different specializations (e.g., primary and secondary education), as well as longitudinal and intervention studies that provide information about changes in pre-service teachers beliefs and strategies as a result of being exposed to professional development programs. Though it seems likely that similar patterns of findings might emerge in research with practicing teachers, this also remains an important area to be investigated in future research.

The research has implications for initial teacher education programs. Despite awareness of the influence of teachers' beliefs on their practices, little has been done so far to take these beliefs into consideration in SRL interventions. Finding effective ways to address the challenges arising from the holding of inconsistent beliefs about the promotion of SRL is a major task for future research and for the education and professional development of teachers.

Conclusions

This research investigated the influence of pre-service teachers' beliefs about learning and teaching on their study practices and their academic performance. For the first time a conceptual change approach was used to investigate beliefs related to the self-regulation of learning, making a distinction between beliefs consistent vs. inconsistent with self-regulation theory. The results demonstrated that the use of cognitive and metacognitive strategies is a statistically significant predictor of pre-service teachers' academic performance as measured by their GPA. They also showed that beliefs about learning and teaching inconsistent with SRL, and especially beliefs that teaching consists mainly in the provision of subject-matter knowledge, were negative predictors of pre-service teachers' use of cognitive and metacognitive study strategies and of their academic performance. Probably the most important finding of the present research was that beliefs consistent with the self-regulation theory

co-exist with beliefs in transmissive teaching, undermining the pre-service teachers' use of cognitive and metacognitive strategies. The results suggest that SRL interventions can become more effective if they address pre-service teachers' (and possibly practicing teachers') opposing beliefs about SRL and increase their knowledge about and use of cognitive and metacognitive learning strategies.

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Compliance with ethical standards

The authors declare that they have no conflict of interest. Permission to undertake this study was sought from and granted by the higher education institution's ethical research committee from which participants were involved. Informed consent was obtained from all participants involved in this research.

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