Effective Self-regulatory Processes in Higher Education: Research Findings and Future Directions

A Systematic Review

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Abstract

Although self-regulated learning (SRL) is assumed to benefit learning outcomes, gaps in the literature make it difficult to describe what constitutes effective SRL in higher education. That is, SRL that relates positively to learning outcomes. In accordance, at present it is unclear how to train effective SRL in higher education. The current systematic review breaks down SRL into self-regulatory processes (SRPs) and reviews the evidence for teaching adolescents effective SRPs. Of the wide variety of SRPs, which are known in the field, the following were investigated in the studies included: Metacognitive strategies, motivation, self-efficacy, handling task difficulty and demands, and resource management. The studies included *(k* = 10; *N* = 906) generally affirmed that all SRL-interventions that were investigated, related positively to SRPs. These SRPs also related positively to learning outcomes. Research is needed to advance the field's understanding of how adolescents develop the wide array of effective SRPs.

Keywords: self-regulatory processes, self-regulatory constructs, self-regulated learning, learning outcomes, systematic review, higher education

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Introduction

Self-regulated learning (SRL) refers to regulating affective, cognitive and behavioral processes in order to learn in a successful manner (Boekaerts and Niemiverta 2000; Pintrich 2000; Sitzmann and Ely 2011; Winne 2011; Zimmerman 2000a). SRL is essential for individuals, particularly with regard to employability and lifelong learning (Schunk and Zimmerman 2001). In addition, SRL is related positively to success in higher education, such as better grades and less academic delay (Grunschel, Patrzek, and Fries 2012; Tuckman 2003). Thus, to prepare individuals for life long learning, and to stimulate study success, higher education should encourage their students to develop SRL.

At present, there is no overview of what exactly *constitutes* effective SRL in higher education. In other words, which self-regulatory processes (SRPs) relate positively to learning outcomes in higher education, is yet unclear. In accordance, it is unknown how effective SRPs can be trained in higher education. The reason for this lack of knowledge is twofold. Firstly, former reviews on the effectiveness of SRL-interventions describe SRL in a holistic fashion (Dignath and Buettner 2008; Dignath, Buettner, and Langfeldt 2008; Hattie, Biggs, and Purdie 1996). That is, without specifying the different SRPs that underlie SRL. Secondly, one recent meta-analysis that examined SRPs in adult learning, investigated only one specific learning outcome, namely training transfer (Sitzmann and Ely 2011). The authors defined the latter as the permanence of trained skills after trainees leave the learning environment. In addition, Sitzmann and Ely did not mention the SRL-interventions that influenced both SRPs and training transfer. In conclusion, to date, there is no overview of SRPs that predict learning outcomes in higher education, and how these can be trained. Thus,

the main purpose of the current review is to gain insight into SRL-intervention studies concerning SRPs and learning outcomes in higher education.

Prior to describing the method used for this systematic review, it is first necessary to briefly outline the theory on SRL and the current knowledge on effective SRPs.

Coming to terms with concepts: SRL, self-directed learning and effective SRPs

SRL

According to Pintrich (2000), four basic assumptions can be identified in SRL-theories. The first is that students construct their learning in an active way. Related to this, a second general assumption in SRL-theories is that self-regulated learners undertake their learning in a purposeful manner. That is, they use standards such as learning goals to decide whether adjustments in SRL are needed. The third general assumption of SRL is that all students are able to self-regulate their learning, but that there are learning environment variables and student characteristics that can prohibit students' SRL. Finally, most SRL-models assume that SRL benefits learning outcomes. Numerous SRL-models have been developed, differing in their underlying theories and, accordingly, in SRL-terminology. In 2000, Pintrich examined the commonalities between SRL-models and developed a general framework for SRL. In this SRL-framework, the author describes four SRL-phases: Forethought, monitoring, control, and reflection. Pintrich states that in each phase students' SRL consists of regulating the SRL-components cognition, motivation, behavior, and task/context content. Finally, for each SRL-phase, Pintrich defined SRPs that students pursue. For example, in the forethought phase it is claimed that students regulate their cognition by SRPs such as goal-setting and prior content knowledge activation (Pintrich 2000).

SRL and self-directed learning

SRL shows significant resemblance to self-directed learning (SDL), a central concept in adult education. Both SDL and SRL expect students to control their learning by governing

SRPs (Garrison 1997; Loyens, Magda, and Rikers 2008; Pilling-Cormick and Garrison 2007). Nevertheless, in contrast with SRL, in SDL it is assumed that the learner exercises more independence in deciding the learning content and learning approach, regardless of educational standards (Garrison 1997; Loyens, Magda, and Rikers 2008; Pilling-Cormick and Garrison 2007). As a result, it can be assumed that the SRPs which Sitzmann and Ely (2011) described specifically for SRL-literature, may also be identified in SDL-literature. Therefore, SDL literature will also be included in this current review— under the condition that one or more SRPs are investigated with respect to learning outcomes in higher education.

Effective SRPs

As stated before, there are learning environment variables that can prohibit students' SRL (Pintrich 2000). The other way round, SRL can be stimulated by adjusting learning environments to SRL. This can be done by implementing one or more educational interventions that are believed to enhance SRL. As it is assumed that SRL influences learning outcomes (Pintrich 2000), an intervention that stimulates SRL also should foster learning outcomes. Former meta-analyses already investigated the implementation of educational interventions and their effectiveness on SRL and learning outcomes (Hattie et al. 1996; Dignath and Buettner 2008; Dignath et al. 2008). These meta-analyses did not investigate whether SRL and learning outcomes were related. So far, only one meta-analysis examined effective SRPs (Sitzmann and Ely 2011).

Sitzmann and Ely (2011) studied whether and how SRPs are effective in college education and workplace training. The authors identified nine predictors for one specific learning outcome; training transfer. Sitzmann and Ely (2011) defined training transfer as the permanence of trained skills after trainees leave the learning environment. The authors distinguished three kinds of SRPs. Firstly, students' self-set performance goal-level is labeled as the initiator for students' SRL. Secondly, a variety of SRPs that students apply in order to

achieve their formulated goal-levels are distinguished, such as planning and monitoring. Finally, students' learning beliefs, for instance about the causes of their study progress, form a separate category of SRPs (Sitzmann and Ely 2011). See Table 1 for the nine effective SRPs that were found by Sitzmann and Ely (2011).

Insert Table 1

It must be noted that Sitzmann and Ely (2011) initially found that another subset of SRPs also constituted SRL: (a) help seeking; (b) emotion control; (c) persistence; (d) planning, and (e) monitoring. However, in their meta-analysis, help seeking, emotion control and persistence could not be significantly and positively linked to training transfer. For planning and monitoring accounted that the authors labeled these SRPs as metacognitive strategies, together with metacognition and learning strategies.

To summarize, previous research on effective SRPs showed a positive influence on training transfer: The permanence of trained skills after trainees leave the learning environment. Which SRPs benefit learning outcomes in higher education remains unknown.

The main goal of the current systematic review is the investigation of relations between SRL-interventions, SRPs, and learning outcomes—in higher education.
The aim of this review is to provide researchers an evidence-based summary in order to guide future research in this area. Thus, the following two research questions were formulated. According to SRL-intervention studies in higher education:

1. Which SRL-interventions influence which SRPs, simultaneously with learning outcomes?
2. Which SRPs relate to learning outcomes?

See figure 1 for a visualization of these two research questions.

Insert Figure 1.

Method

Procedure

This study followed the method for conducting systematic reviews of Petticrew and Roberts (2008). Therefore, the review contained the following phases. First, the criteria for inclusion were determined. Second, the appropriate databases and search terms were formulated. Third, extensive literature research was conducted. Fourth, computing effect sizes resulted in standardized data. Finally, the data were synthesized by type of SRP and related with learning outcomes. Because of the heterogeneity of the studies with respect to the SRPs, a meta-analysis was not performed. That is, the different effect sizes were computed, but not the mean effect sizes.

Criteria for inclusion

1. *Purpose of the study:* This review focuses on the effectiveness of SRL-interventions in higher education. This type of learning can unfold in different learning environments: In the classroom, in simulated learning environments, or during workplace learning. Important is that the learning and learning outcomes are embedded in the prevailing curriculum. Therefore, laboratory sessions were not included.
2. *SRL-interventions:* The SRL-interventions as investigated in this systematic review should aim at developing SRPs and learning outcomes within higher education. Both SDL and SRL expect students to control their learning by governing the different SRPs that can be identified in SRL-literature (Garrison 1997; Loyens, Magda, and Rikers 2008; Pilling-Cormick and Garrison 2007). Therefore, the SDL-literature was also included in the current review.
3. *SRPs*: This review builds on the meta-analysis of Sitzmann and Ely (2011). In accordance, three kinds of SRPs were distinguished. Firstly, students' self-set performance goal-level was labeled as the initiator for students' SRL. Secondly, a

variety of SRPs that students apply in order to achieve their formulated goal-levels were distinguished, such as planning and monitoring. Finally, students' learning beliefs, for instance about the causes of their study progress, formed a separate category of SRPs (Sitzmann and Ely 2011). See Table 1 for the nine SRPs that guided this systematic review (Sitzmann and Ely 2011).

4. *Learning outcomes:* According to Bloom's taxonomy (1956), learning can be distinguished in higher order level learning (HLL) and lower order level learning (LLL). HLL refers to applying, analyzing, evaluating, and creating. LLL stands for remembering and understanding (Anderson et al. 2000). In accordance with Anderson et al. (2000), in the current review learning outcomes were labelled as either LLL or HLL. For example, a knowledge test consisting of multiple-choice questions measures how well students remember facts, hence LLL. Yet, if students need to design a website by applying knowledge, this was defined as HLL.
5. *Student characteristics:* In order to generalize the results to school learning in higher education, studies should concern students in (post-) tertiary education. Participating students should not be selected on being excellent, gifted, or suffering from learning disabilities. Rather, they should be representative for the general school community.
6. *Research design:* For assuring a methodological standard, the design in the included studies had to be an experimental pre-test post-test design including a control group with random assignment.
7. *Results:* In order to be able to standardize the results, the data had to be quantitative, either reporting effect sizes, or present sufficient information to compute effect sizes.
8. *Quality of the study:* Studies had to be published in English, and had to be listed in the Social Science Citations Index (Expanded). Finally, the study had to be accurate in

reporting results, for example, the number of participants must have been mentioned in the article.

Databases and search terms

The most commonly used databases for educational research, namely ERIC, Psychinfo, and Scopus were explored. As studies on the effectiveness of curricula promoting SRL are well spread amongst health disciplines, Pubmed and Cinahl were also examined. Search terms related to SRL-interventions concerned: *educational environment*; *independent study*; *student activism*; *individualized instruction*; *education*; *active learning*; *learner centered instruction*; *learning methods*; *school environment*; *portfolio*; and *feedback (response)*. Search terms that regarded **SRL** were: *self-regulat** and *self-direct**. The search term for **learning outcomes** was *learning outcomes*.

Study selection and data-extraction

The selection of studies and the interpretation of data were done independently by two co-authors and the first author, by using a self-devised data-extraction form. An inter-rater reliability of 90% was reached for both the selection of studies and the coding of the outcome measures, as obtained individually. The remaining 10% of the articles were discussed thoroughly, due to divergent individually obtained results. Finally, consensus was reached in these sessions.

Coding of outcome measures

SRL outcome variables should match one of the SRPs that Sitzmann and Ely (2011) defined as a predictor for training transfer. lf a SRP could not be matched with one that was found by Sitzmann and Ely's meta-analysis (2011), this was included in the category 'other'.

Applying the taxonomy of Bloom, learning outcomes were categorized in LLL and HLL (Anderson et al., 2000).

Effect size computations for SRL and learning outcomes

The coded outcome variables were quantified in a standardized way, by using effect sizes. This was done for two reasons. The first reason for using effect sizes was to assure the different outcome variables concerning SRL processes and learning outcomes could be compared. The second was to value the potential of a SRL-intervention. Especially for studies with a small sample size an effect size may indicate that, although a significance level is not reached, there is a SRL-intervention impact. Therefore, either the effect sizes of the included studies were reported, or, if not available, were computed (See also Crutzen 2010). Concerning the latter, for each obtained measure the mean difference was computed between the treatment group and the control group, divided by the pooled standard deviation. This standardized mean difference is Cohen's *d* (Cohen 1992). If the mean and standard deviation were not reported, effect sizes were computed by using the formulas as described by Lipsey and Wilson (2001). The same procedure was followed for standardizing the SRL measurements. Following Cohen (1992), an effect size was considered low ($0.20 < d \leq 0.50$), moderate ($0.50 < d \leq 0.80$), or high ($d \geq 0.80$). As noted before, several effect sizes could be computed for each study.

Results

Results search strategy

Ten studies were included in the final analysis and data synthesis. The different steps in the study selection process and the obtained studies are visualized in Figure 2.

Insert Figure 2.

Presence versus absence of various SRPs across different intervention studies

In the studies included, three out of the nine SRPs that Sitzmann and Ely (2011) concluded to be related to learning outcomes had been looked into, namely metacognitive strategies, motivation, and self-efficacy. In addition, two studies included investigated two SRPs that Sitzmann and Ely (2011) did not found to be a predictor for training transfer. These

were *handling task difficulty and demands* and *resource management.* See Table 2 for an overview of the SRPs that had been examined in the studies included.

Insert Table 2.

Which SRL-interventions influence which SRPs, simultaneously with LLL and HLL?

In the following, the 10 studies included are described according to the SRPs that they investigated. The participants, the SRL-interventions, and their effects on SRPs and learning outcomes are discussed in the below. For specific study details see Table 3.

Insert Table 3.

Metacognitive strategies

Two studies (3,4) investigated self-metacognitive questioning amongst teacher students. These questions focus on students' understanding of the task and on students' self-regulation. Both studies, undertaken by the same researchers showed a positive influence on students' metacognitive strategies and HLL.

A third study (10) investigated the effectiveness of reflection prompts, with and without tutor feedback. The reflection prompts were meant to evoke reflections on the students' learning process. The reflection prompts condition generated no impact on LLL. The reflection prompts condition with feedback condition had a moderate impact on LLL. The students concerned distance education students.

The three studies as described above investigated SRL-interventions with respect to metacognitive strategies, in general (3,4,10). Another three studies examined certain metacognitive strategies; planning, monitoring, learning strategies, and calibration (1,7,8).

The first study (1) prompted psychology students to use metacognitive strategies such as planning and monitoring, and to develop cognitive strategies, for example, summarizing or hypothesizing. This SRL-intervention influenced planning, monitoring, LLL, and HLL in a positive manner. However, this study reported a negative effect on learning strategies.

The second study found that four guiding questions had a high impact on planning, monitoring, and learning strategies, and a moderate effect on HLL. The participants concerned education students. However, in a second treatment group, the participants were provided with four guiding questions and, additionally, with digital feedback. The four guiding questions with digital feedback condition were found to have a high impact on planning and monitoring, but none on learning strategies, and a marginal effect on HLL. The author concluded that students in the feedback condition performed less well because the feedback consisted of knowledge of results (7). The students who received positive feedback students may have concluded that they had learned sufficient enough, concerning this part of study. This may have led to a decrease or discontinuation of students' learning strategies, and thus to lower performance (7).

The third study (8) examined whether digital feedback on monitoring exercises was related to students' calibration competence. The latter refers to the students' ability of matching their *perception* of their own performance with their *actual level* of performance. For the teacher students it turned out that digital feedback had both moderate effects on calibration and test performance.

Motivation

One study (9) found that instruction had a small, positive, effect on students' motivation to learn. Another two studies (3,4) concluded that self-metacognitive prompts influenced motivation in a positive manner. Finally, one study (10) found that reflection prompts and tutor feedback generated positive effects on motivation. However, for studies 3 and 4 accounted that motivation was conceptualized as a combination of two different SRP's: Motivation, and self-efficacy. For this reason, it is unclear what effect concerned motivation to learn, and which effect regarded self-efficacy.

In contrast with the four studies that described positive effects on motivation (3,4,9,10), two studies showed that feedback had a negative effect on the motivation of psychology students (1) and nursing students (2). With respect to study 2, learning motivation included a self-efficacy scale. As a result, it is unclear, which effect was on learning motivation and which one was on self-efficacy. Concerning study 1, it must be remarked that, although motivation was influenced negatively, metacognitive strategies as well as learning outcomes were influenced in a positive manner. The goal of study 2 was to improve students' electrical reading of the heart (ECG-recordings), in order to investigate heart disease. The authors concluded that students who were taught using a traditional lecture format *interpreted* ECG-recordings significantly more effectively, compared to students taught using Web-based instruction. The authors suggest that the immediate feedback opportunity in web-based learning influenced the ability to interpret ECG recordings positively, perhaps due to its visual stimulation and flexibility. However, although students in the treatment group outperformed the students in the control group for interpretation of ECG knowledge, this did not account for ECG knowledge. The ECG knowledge as obtained by students in the treatment group was significantly lower than that of the students in the control group.

Self-efficacy

The first study (5) investigated the relations between debriefing of nursing students by an instructor, self-efficacy and learning outcomes. This SRL-intervention showed to be effective with respect to self-efficacy, a knowledge test (LLL) and a behavioral assessment test (HLL), but not in relation with a technical evaluation test (HLL).

In another study concerning nursing students (6), an interactive e-drug calculations package was introduced. This SRL-intervention was moderately effective on drug calculation self-efficacy and HLL.

A third study investigated self-efficacy (9). This time, participants concerned business education students who received a training script including SRL-information, prior to the training. This pre-training script asked them to focus on learning goals. In addition, statements such as "You are a capable learner" stimulated students' self-efficacy. The pre-training script had a positive influence on computer learning self-efficacy, LLL, and HLL. In the second experiment, the same cohort of students was randomly assigned to the treatment or control group. This second condition concerned a script *during* the training; a midpoint control script that evaluated students' learning and asked them to focus on SRL aspects, such as paying attention and monitoring their learning progress. The latter had a small effect on computer learning self-efficacy, LLL, and HLL.

It must be remarked that another four studies investigated self-efficacy, but as a subscale of motivation (2,3,4,10). All four studies generated positive effects on motivation, including the mentioned subscale of self-efficacy. As a consequence, it is unclear what effect size was generated by self-efficacy and which one by motivation (see also the section on motivation for the concerning effect sizes).

Finally, one study reported no effect on self-efficacy (8). It is unclear what caused this.

Handling task difficulty and demands, and resource management

Two studies investigated a SRP that was not identified as a predictor of training transfer by Sitzmann and Ely (2011). In one study, handling task difficulty and demands was investigated (1). The latter referred to *control of context, help seeking behavior, expressing task difficulty, expect adequacy of information,* and *time and effort planning.* The authors suggested that human coaching had a small impact on handling task difficulty and demands. In addition, small to moderate effects were found with respect to LLL and HLL. In study 10 a similar SRP as handling task difficulty and demands was studied. The authors called this SRP

resource management, that referred to time and study environment, peer learning, help seeking and effort regulation. Similar to study 1 that reported a small impact on handling task difficulty and demands, study 10 reported a small impact on resource management. Study 1 concerned two treatment groups. The reflection prompts condition generated no impact on LLL. The reflection prompts with tutor feedback condition showed a moderate impact on LLL.

Which SRPs relate to LLL and HLL?

In seven studies, the authors hypothesized and found that SRPs were related positively to learning outcomes (1,4,5,7,8,9,10). Three other studies (2,3,6) did not investigate the hypothesis that SRPs and learning outcomes are related. In Table 3, the last column, it is specified whether or not the SRP's as investigated, were found to be related positively to learning outcomes. It must be noted that in study 10, the authors only reported positive correlations between LLL and two out of the six MSLQ-scales; the Expectancy scale (control of learning beliefs and self-efficacy) and the Test anxiety scale. The authors argued that the reflection prompts applied to other SRPs than were measured by the MSLQ-scales.

Discussion

The dual aim of this review was 1) to examine the effectiveness of SRL-interventions with respect to SRPs and learning outcomes in higher education, and 2) to investigate whether improved SRPs benefit learning outcomes in higher education. The overall results reveal that in all studies included (k = 10) SRL-interventions related positively to SRPs as well as to learning outcomes. These SRL-interventions concerned (non-) human coaching, instruction, and the introduction of a SRL-stimulating environment. The introduction of e-learning alone, did not relate positively to metacognitive strategies (2) and motivation (2,3). This is in line with the study of Azevedo (2011) that showed that the introduction of e-learning should be accompanied by human coaching in order to be fruitful for SRL and

learning. In three studies included, SRL-interventions influenced motivation negatively (1,2,10). However, it is difficult to interpret this negative influence on motivation. The first is that for two studies accounted that motivation included a subscale; self-efficacy (2,10). Thus, for these studies it is unclear whether motivation and/or self-efficacy was negatively influenced (2,10). Related to this, the fact that self-efficacy was not measured separately from motivation (2,10), or was not measured at all (1), could have led to valuable missing information. Namely, it is stated that self-efficacy influences motivation positively (Multon, Brown, and Lent 1991). Possibly, in the concerning studies a positive influence on self-efficacy had not yet been established. As a result, motivation may have been influenced in a negative manner.

In the studies included, three out of the nine SRPs distinguished by Sitzmann and Ely (2011) have been studied, namely metacognitive strategies, motivation, and self-efficacy. The following SRPs have not been addressed: Goal-level, attention, time management, environmental structuring, effort, and attributions. In addition, two studies examined two SRPs that Sitzmann and Ely did not found do be a predictor for training transfer. These were handling task difficulty and demands and resource management.

Seven studies included showed a positive relation between SRPs and learning outcomes. Another three studies did not hypothesize SRPs to be related to learning outcomes. However, it is likely that the SRPs studied would relate positively to learning outcomes, if only this had been investigated. Namely, if effect sizes concerning SRPs were positive, effect sizes for learning outcomes also revealed to be positive (see Table 3).

In sum, the current review indicates that the following SRPs constitute effective SRL in higher education, that is, SRL that benefits learning outcomes: Metacognitive strategies, motivation, self-efficacy, handling task difficulty and demands, and resource management. With this knowledge of effective SRPs, as presented in this review, students' SRL-level can

be diagnosed. Such a SRL-diagnosis could be used by the student to improve his/her learning. Another opportunity is to use this SRL-diagnosis for the customization of coaching and instruction to the student, in order to benefit students' SRPs as well as learning outcomes. This review also provides an overview of SRL-interventions that can be used to train effective SRPs in higher education (see Table 3).

Strengths and limitations of this systematic review

A strength of this current review was that for each study the effect sizes were included, or computed, for the outcome measures. As a result, Cohen's *d* was computed for SRPs as well as for learning outcomes, that is, for LLL and HLL. This process led to comparable statistics for SRPs, LLL and HLL across studies. In addition, the effect sizes generated extra information concerning the potential of SRL-interventions, on top of the significance levels that had been reported in the studies included (See also Crutzen 2010).

A limitation of this study concerns the number of participants of study 5, namely 16. Although this study met our criteria for inclusion, the validity of this study's results (5) can be seriously doubted.

Recommendations for further research

The SRPs that Sitzmann and Ely (2011) found to predict one specific learning outcome, training transfer, have shown to be a worthwhile means for identifying SRPs that relate positively to learning outcomes in higher education. However, only three out of the nine SRPs that Sitzmann and Ely (2011) found to be positively related to learning outcomes were investigated in the 10 studies included. These were metacognitive strategies, motivation, and self-efficacy. For future research, it would be worthwhile to investigate how individuals develop the wide array of different SRPs over time, and how these can be trained in higher education.

In their meta-analysis, Sitzmann and Ely (2011) did not find planning and monitoring to influence training transfer, individually. Therefore, the authors labeled planning and monitoring as metacognitive strategies, together with metacognition and learning strategies. In contrast, in this systematic review, two studies found that coaching influenced both planning, monitoring, and learning outcomes. Learning strategies were not found to be influenced by coaching (1,7). Therefore, it is recommended that future research into SRPs investigates metacognition, planning, monitoring, and learning strategies separately, instead of categorizing these variables under metacognitive strategies. Furthermore, Sitzmann and Ely (2011) concluded that help seeking did not predict learning outcomes. However, two studies reported positive effects on help seeking (1,10). The first study (1) found that handling task difficulty and demands positively influenced learning outcomes in higher education. Handling task difficulty and demand concerned *help seeking behavior,* and also*; control of context, expressing task difficulty, expect adequacy of information*, and *time and effort planning.* The second study reported a small impact on resource management. The authors defined this concept as help seeking, time and study environment, peer learning, and effort regulation. As a result, future research into SRPs and learning outcomes should also include *handling task difficulty and demands*, or *resource management*, as a SRP.

The studies on motivation generated mixed results. Four studies reported a positive effect on motivation (3,4,9,10). However, it must be noted that in three of these studies motivation included a subscale of self-efficacy (3,4,10). Therefore, the true effect size for motivation is unclear for these studies. It is recommended that future research addresses motivation, that is; the willingness to learn, separately from self-efficacy.

Finally, it is noteworthy that although the literature claims that several SRL stimulating environments are effective (Biggs 1999, 2003; Buckley et al. 2009; Narciss 2007), only e-learning and hypermedia learning were specifically mentioned in the studies

included. Other SRL-stimulating environments, such as problem-based learning and portfolio-based learning were not examined in a pre-test post-test design with a control group. It would be worthwhile to compare the effectiveness of SRL stimulating environments such as PBL, portfolio-based learning, or e-learning to each other or to traditional learning environments.

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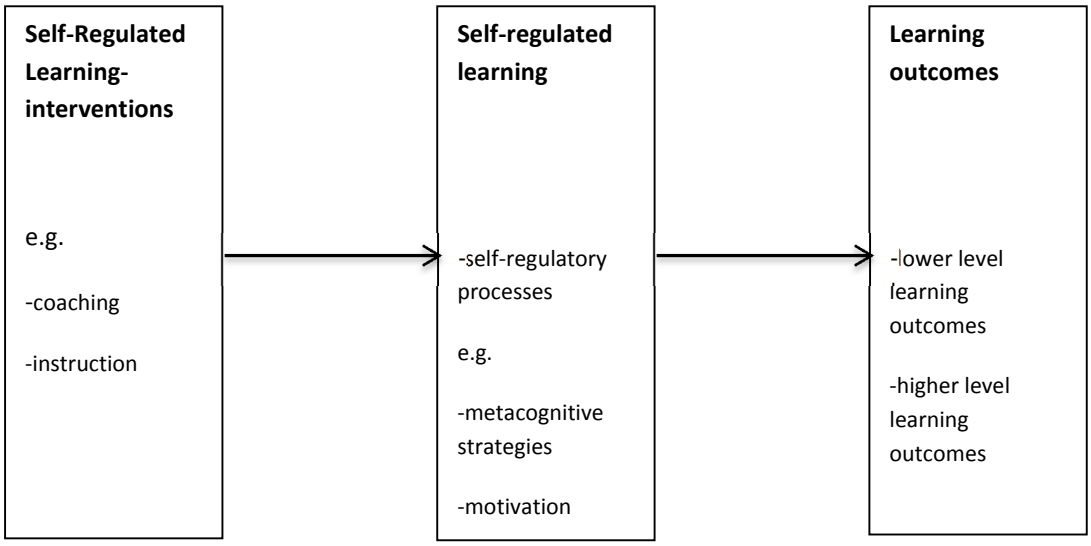

Figure 1. Conceptual model Self-Regulated Learning-interventions, self-regulatory processes, and learning outcomes

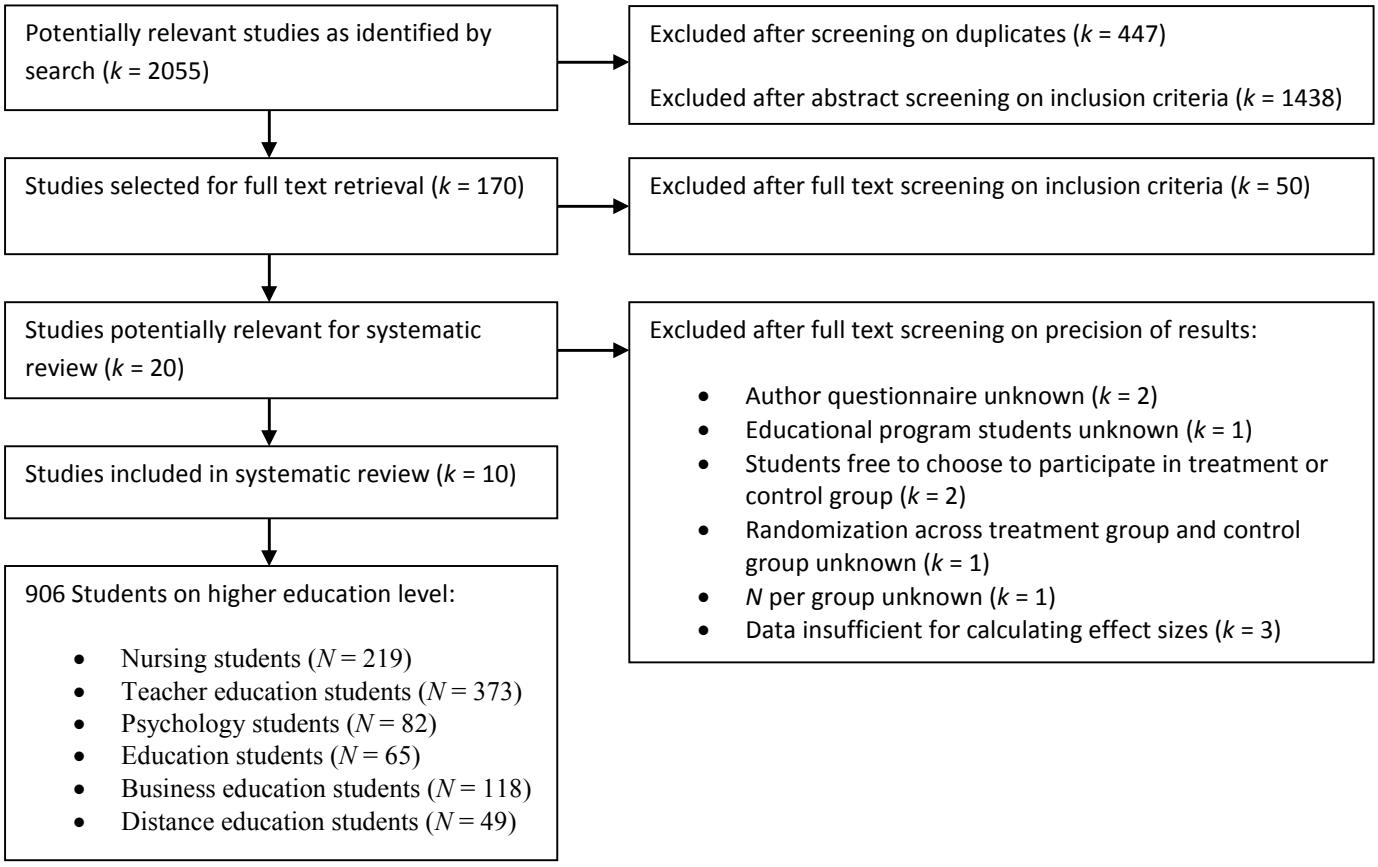

Figure 2. Study selection process

Table 1

Self-regulatory processes that predict training transfer (Sitzmann and Ely 2011)

Self-regulatory processes	Definition
SRL initiator	
Goal-level	Self-set performance goal level (Vancouver and Day 2005)
Processes that students use for goal-achieving	
Metacognitive strategies	Metacognition, planning, monitoring, and learning strategies
Attention	The degree to which students stay focused during training (Zimmerman 2000b)
Time management	Making a time-schedule for learning
Environmental structuring	Choosing a study location that is fruitful for learning (Pintrich 2000)
Motivation	The willingness to learn
Effort	The time that students devote to their learning (Zimmerman and Risenberg 1997)
Students' learning beliefs	
Attributions	Students' beliefs about the causes of their study progress (Zimmerman, 2000b)
Self-efficacy	Students' beliefs regarding their learning capability (Bandura 1977)

Table 2

Self-regulatory processes examined in studies included in the systematic review (as found by Sitzmann and Ely (2011)*

	Self-regulatory processes in order to achieve learning goals		Learning belief	Other self-regulatory processes[a]	
	Metacognitive strategies	Motivation	Self-efficacy	Handling task difficulty and demands	Resource management
1. Azevedo et al. (2007)	✓	✓		✓	
2. Jang et al. (2005)		✓			
3. Kramarski and Michalsky (2009)	✓	✓			
4. Kramarski and Michalsky (2010)	✓	✓			
5. Leflore et al. (2007)			✓		
6. McMullan et al. (2011)			✓		
7. Moos (2011)	✓		✓		
8. Nietfeld et al. (2006)	✓				
9. Santhanam et al. (2008)		✓	✓		
10. Van den Boom et al. (2007)	✓	✓			✓

Note**.** The following self-regulatory processes that Sitzmann and Ely found to be related positively to training transfer were not examined in the studies included: Goal-level, attention, time management, environmental structuring, effort, and attributions.

[a]A self-regulatory process that was examined in the studies included. Sitzmann and Ely (2011) did not found this self-regulatory process to be related positively to training transfer.

Table 3

Training information of the intervention studies that measured the effectiveness of SRL-interventions on self-regulatory processes and learning outcomes (k = 10)

	Participants	Treatment group, learning environment	Control group, learning environment	Self-regulatory processes (SRPs)	*d*	Effect *d*	Measurement instrument SRPs	Measurement test Learning outcomes	LLL/ HLL[a]	*d*	Effect *d*	SRP and LLL/ HLL[b]
1	Psychology students (*N* = 82)	1.An overall learning goal and scaffolding, hypermedia learning (*n* = 41)	An overall learning goal, hypermedia learning (*n* = 41)	*Metacognitive strategies*			Think aloud protocols; students verbalizations about SRL constructs, recorded on audio and videotape. Coding scheme designed by Azevedo, Cromley and Seibert (2004)	-Matching task	LLL	0.08*	0	nr
								-Labeling task	LLL	0.67*	++	r
				Planning	0.56	++		-Blood flow diagram	HLL	0.60*	++	r
				Monitoring	0.43	+						
				Strategy use	-0.07	-		-Mental model task	HLL	0.49	+	r
				Motivation	-0.23	-						
				Handling task difficulty and demands	0.23	+						
2	Nursing students (*N* = 105)	1.Web-based ECG learning program + immediate, digital, feedback (*n* = 54)	Face-to-face learning + human coaching (*n* = 51)	*Motivation*	-0.15	-	Korean version of Keller's (1987) Instructional Materials Motivation Survey	-Mpc test	LLL	-0.68	-	ni
								-Interpreting test	HLL	0.54*	++	ni
3	Teacher students (*N* = 194)	1.E-learning (*n* = 53)	Face-to-face learning (*n* = 46)	*Metacognitive strategies*			Motivated Strategies for Learning Questionnaire (Pintrich et al. 1991)	Comprehending skills test	HLL	0.25*	+	ni
				Cognition	-0.08	-		-Designing skills test	HLL	0.33*	+	ni
				Metacognition	-0.08	-						
				Motivation	0.11	0						
		2. Self- metacognitive questioning (digitally), e-learning (*n* = 47)		*Metacognitive strategies*				Comprehending skills test	HLL	1.01*	+++	ni
				Cognition	0.78	++		-Designing skills test	HLL	1.20*	+++	ni
				Metacognition	0.57	++						
				Motivation	0.61	++						
		3.Self-metacognitive questioning (on paper), face-to-face learning (*n* = 48)		*Metacognitive strategies*				Comprehending skills test	HLL	0.40*	+	ni
				Cognition	0.30	+		-Designing skills test	HLL	0.57*	++	ni
				Metacognition	0.23	+						
				Motivation	0.33	+						

Note**.** An effect size was considered negative ($d \leq 0.00$), zero ($0.00 < d \leq 0.20$), small ($0.20 < d \leq 0.50$), moderate ($0.50 < d \leq 0.80$), or high ($d \geq 0.80$).
Subsequently, in table 3 effect sizes are labeled negative (-), zero (0), small (+), moderate (++) or high (+++).
[a]Lower order level learning (LLL) / Higher order level learning (HLL)
[b]related (r) / not related (nr) / not investigated (ni)
*Significant effects as reported in study

Table 3 (continued)

	Participants	Treatment group, learning environment	Control group, learning environment	Self-regulatory processes (SRPs)	*d*	Effect *d*	Measurement instrument SRPs	Measurement test Learning outcomes	LLL/ HLL[a]	*d*	Effect *d*	SRP and LLL/ HLL[b]
4	First year teachers for high schools in the sciences (*N* = 95)	1.Online self-metacognitive questioning, hypermedia learning (*n* = 47)	Hypermedia learning (*n* = 48)	*Metacognitive strategies* Cognition Metacognition *Motivation*	 1.07 0.93 0.85	 +++ +++ +++	Motivated Strategies for Learning Questionnaire (MSLQ), developed by Pintrich et al. 1991)	Comprehension skills -Design skills	HLL HLL	1.64 1.43	+++ +++	r r
5	Nursing students on master's level (*N* = 16)	1.A clinical simulated experience. Afterwards, human coaching, instructor-modeled learning (*n* = 6)	A traditional lecture and a clinical simulated experience, traditional didactic learning (*n* = 5)	*Self-efficacy*	1.46*	+++	Michael's adaptation of the self efficacy tool (Michael 2005), originally developed by Schwarzer and Jerusalem in 1979 (Schwarzer and Jerusalem 1995)	-Knowledge test -Technical evaluation -Behavioral Assessment	LLL HLL HLL	1.58 -0.27 0.57*	+++ - ++	nr nr r
		2.A clinical simulated experience. Afterwards, students were provided with a facilitated debriefing, self-regulated learning (*n* = 5)		*Self-efficacy*	2.12*	+++		-Knowledge test -Technical evaluation -Behavioral Assessment	LLL HLL HLL	0.58 -0.36 0.43	++ - +	nr nr r
6	Nursing students (*N* = 98)	1. September cohort: an interactive e-drug calculations package, e-learning (*n* = 32)	A paper handout, face-to-face learning (*n* = 16)	*Self-efficacy* Drug calculation self-efficacy	 0.52	 ++	Six items, validated in a pilot with 22 students (Cronbach's alpha 0.9), by McMullan	-A drug calculation test	HLL	0.67*	++	ni**
		2. As described above, for the February cohort (*n* = 26)	A paper handout, face-to-face learning (*n* = 24)	*Self-efficacy* Drug calculation self-efficacy	 0.67*	 ++		-A drug calculation test	HLL	0.48*	+	ni**

Note. An effect size was considered negative ($d \leq 0.00$), zero ($0.00 < d \leq 0.20$), small ($0.20 < d \leq 0.50$), moderate ($0.50 < d \leq 0.80$), or high ($d \geq 0.80$).
Subsequently, in table 3 effect sizes are labeled negative (-), zero (0), small (+), moderate (++) or high (+++).
[a]Lower order level learning (LLL) / Higher order level learning (HLL)
[b]related (r) / not related (nr) / not investigated (ni)
*Significant effects as reported in study

Table 3 (continued)

	Participants	Treatment group, learning environment	Control group, learning environment	Self-regulatory processes (SRPs)	*d*	Effect *d*	Measurement instrument SRPs	Measurement test Learning outcomes	LLL/ HLL[a]	*d*	Effect *d*	SRP and LLL/ HLL[c]
7	Education students (*N* = 65)	1.Four guiding questions, hypermedia learning (*n* = 26)	No four guiding questions, hypermedia learning (*n* = 21)	*Metacognitive strategies*			-A modified MSLQ self-efficacy scale (Pintrich et al. 1991). -Think aloud protocol (Ericsson 2006; Ericsson and Simon 1994)	-Essay	HLL	0.47*	+	r
				Planning	1.45*	+++						
				Monitoring	1.43*	+++						
				Strategies	0.88*	+++						
				Self-efficacy	0.68*	++						
		2.Four guiding questions, and immediate digital feedback on answers (knowledge of results), hypermedia learning (*n* = 18)		*Metacognitive strategies*			-A modified MSLQ self-efficacy scale (Pintrich et al. 1991). -Think aloud protocol (Ericsson 2006; Ericsson and Simon 1994)	-Essay	HLL	0.03*	0	r
				Planning	1.31*	+++						
				Monitoring	0.94*	+++						
				Strategies	0.13	0						
				Self-efficacy	0.28*	+						
8	Students teacher education (*N* = 84)	1.Instruction: Monitoring exercises and digital feedback, learning environment undefined (*n* = 45)	Monitoring exercises, learning environment undefined (*n* = 39)	*Metacognitive strategies*			Monitoring accuracy test (Keren 1991; Yates 1990)	-Test score -Schema score	LLL HLL	0.76* 0.64*	++ ++	r r
				Calibration	0.64*	++						
				Self-efficacy	-0.14	-						
9	Business education students (*N* = 118)[b]	1.Instruction: A pretraining script on task analysis and learning goals. Also, this script stimulated self-efficacy beliefs, e-learning (*n* = 61)	A pretraining control script without SRL information, e-learning (*n* = 57)	*Motivation* *Self-efficacy* Computer learning self-efficacy	0.37* 0.23	+ +	Learning orientation scale and computer learning self-efficacy scale (Zweig and Webster 2004).	-Declarative knowledge test -Hands-on performance test	LLL HLL	0.58* 0.35*	++ +	nr nr
		2.Instruction: A midpoint script that asked to focus on aspects of self-regulated learning, e-learning (*n* = 61)	A midpoint control script, not focused on SRL, e-learning (*n* = 57)	*Motivation* *Self-efficacy* Computer learning self-efficacy	0.35* 0.21	+ +	Learning orientation scale and computer learning self-efficacy scale (Zweig and Webster 2004).	-Declarative knowledge test -Hands-on performance test	LLL HLL	0.36* 0.27*	++ +	nr nr

Note**.** An effect size was considered negative ($d \leq 0.00$), zero ($0.00 < d \leq 0.20$), small ($0.20 < d \leq 0.50$), moderate ($0.50 < d \leq 0.80$), or high ($d \geq 0.80$).
Subsequently, in table 3 effect sizes are labeled negative (-), zero (0), small (+), moderate (++) or high (+++).
[a]Lower order level learning (LLL) / Higher order level learning (HLL)
[b] The same cohort was randomly assigned to the treatment or control group
[c]related (r) / not related (nr) / not investigated (ni)
*Significant effects as reported in study

Table 3 (continued)

	Participants	Treatment group, learning environment	Control group, learning environment	Self-regulatory processes (SRPs)	Effect *d*		Measurement instrument SRPs	Measurement test Learning outcomes	LLL/ HLL[a]	Effect *d*		SRP and LLL/ HLL[b]
10	Distance education students engaging in a course psychology (*N* = 49)	1.Reflection prompts, hypermedia learning (*n* = 16)	Neither reflection prompts nor tutor feedback, hypermedia learning (*n* = 18)	*Metacognitive strategies*			Motivated Strategies for Learning Questionnaire (Pintrich et al. 1991)	-Knowledge test	LLL	0.12	0	r
				Cognitive strategy scale	0.72	++						
				Metacognitive strategy scale	0.28	+						
				Motivation								
				Value scale	0.65*	++						
				Expectancy scale	0.03	0						
				Test anxiety scale**	0.28	-						
				Resource management scale	0.24	+						
		2.Reflection prompts. In addition, feedback was given by a tutor, hypermedia learning (*n* = 15)		*Metacognitive strategies*				-Knowledge test	LLL	0.60*	++	r
				Cognitive strategy scale	0.92	+++						
				Metacognitive strategy scale	0.68	++						
				Motivation								
				Value scale	0.81*	++						
				Expectancy scale	-0.18	-						
				Test anxiety scale**	-0.73	++						
				Resource management scale	0.38	+						

Note**.** An effect size was considered negative ($d \leq 0.00$), zero ($0.00 < d \leq 0.20$), small ($0.20 < d \leq 0.50$), moderate ($0.50 < d \leq 0.80$), or high ($d \geq 0.80$).
Subsequently, in table 3 effect sizes are labeled negative (-), zero (0), small (+), moderate (++) or high (+++).
[a]Lower order level learning (LLL) / Higher order level learning (HLL)
[b]related (r) / not related (nr) / not investigated (ni)
*Significant effects as reported in study
**A negative *d* for the test anxiety scale indicates a decrease in test anxiety