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Self-regulated learning strategies & academic achievement in online higher education learning environments: A systematic review

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ABSTRACT

As enrolments in online courses continue to increase, there is a need to understand how students can best apply self-regulated learning strategies to achieve academic success within the online environment. A search of relevant databases was conducted in December 2014 for studies published from 2004 to Dec 2014 examining SRL strategies as correlates of academic achievement in online higher education settings. From 12 studies, the strategies of time management, metacognition, effort regulation, and critical thinking were positively correlated with academic outcomes, whereas rehearsal, elaboration, and organisation had the least empirical support. Peer learning had a moderate positive effect, however its confidence intervals crossed zero. Although the contributors to achievement in traditional face-to-face settings appear to generalise to on-line context, these effects appear weaker and suggest that (1) they may be less effective, and (2) that other, currently unexplored factors may be more important in on-line contexts.

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1. Background

Increased internet access in the past decade has led to a rapid increase in the number of students electing to undertake their higher education learning experience online, rather than in traditional face-to-face settings (Greenland & Moore, 2014). In contrast to traditional learning where student/teacher interaction and communication occur face-to-face in a classroom (Artino & Jones, 2012), online learning relies on the use of asynchronistic and synchronistic interaction and communication within a virtual environment (Ku & Chang, 2011).

Online courses have several advantages over traditional settings. Web-based learning provides flexibility and accessibility for students whose schedule or location makes it difficult to attend a physical class (Waschull, 2001). Further, students who study online, compared to those in traditional classrooms, have more opportunities to learn information, additional access to learning resources, and greater opportunities for collaboration (U.S. Department of Education, 2009). Unlike face-to-face classes, the online environment exceeds standard synchronous education where students learn at the same time and place, and provides for asynchronous learning in which space and time are not barriers (Ku & Chang, 2011).

In spite of these benefits, success in an online learning environment heavily relies on a student's ability to autonomously and actively engage in the learning process (Wang, Shannon, & Ross, 2013). Online students are required to be more independent, as the very nature of online settings promotes self-directed learning (Serdyukov & Hill, 2013). It is therefore particularly important that online learners compared to their traditional classroom peers, have the self-generated ability to control, manage, and plan their learning actions (Ally, 2004). Such a regulatory process has been referred to as self-regulated learning (SRL; Zimmerman, 2008).

The relationship between self-regulated learning and academic achievement has been theorised under the social cognitive view that self-regulated learning is acquired through a triadic interaction between three important characteristics: a) self-observation (monitoring one's actions) seen as the most important of these processes; b) self-judgement (evaluation of one's performance), and c) self-reactions (one's response to performance outcomes; Zimmerman, 1989). More importantly, this view postulates that learning is not merely a fixed trait, but can be influenced and improved with the aim of achieving successful academic outcomes (Zimmerman, 1989). Students may use a variety of cognitive, metacognitive, and resource management SRL strategies as part of their SRL behaviour (Puzziferro, 2008). Cognitive strategies such as rehearsal aim to help learners acquire knowledge at a surface level by retaining information. Metacognitive strategies refer to the awareness to monitor, plan, and regulate learning (Yukselturk & Bulut, 2007), and resource management strategies require students to use resources around them such as their peers (Puzziferro, 2008). Self-regulated learning strategies affect learning outcomes by assisting learners to acquire and retain knowledge in a structured and methodological way. Strategies are part of the SRL process and are specific skills that can be taught to students to put into real world practice (Zimmerman, 1989). The application of SRL strategies typically predicts high academic achievement in the traditional learning environment (Wang et al., 2013).

Academic achievement (in both traditional and online learning settings) can be generally defined as achieving a particular result in an online assignment, exam, subject, or degree, and is ordinarily expressed in terms of a numerical grade or grade point average (GPA; Richardson, Abraham, & Bond, 2012). Research has shown positive relationships between the use of SRL strategies and academic outcomes in traditional learning settings (Beishuizen & Steffens, 2011; Dignath & Buttner, 2008; Pintrich, 2004; Richardson et al., 2012; Zimmerman, 2008). Within the traditional learning environment, the SRL strategies with the strongest findings are metacognition, time management, and effort regulation (Richardson et al., 2012). However, little comparative research has been conducted on the use of SRL in the online learning environment to determine whether these strategies are of equivalent use. Exploration of predictors of online learning success is becoming increasingly important as more students are taking advantage of the flexibility and accessibility online courses.

The aim of this review was to understand how students could best apply self-regulated learning strategies to achieve academic success within the online environment. This was achieved by evaluating empirical studies from the last decade that have examined SRL strategies associated with academic outcomes in online settings. Specifically, this review investigates which learner self-regulation strategies are correlates of academic achievement in online higher education environments. This review adhered to guidelines set by the PRISMA statement for systematic reviews (Moher, Liberati, Tetzlaff, & Altman, 2009).

2. Methods

2.1. Eligibility criteria

Papers were restricted to peer reviewed journal papers published within the last decade in English language journals between the years 2004 to Dec 2014.

2.2. Search strategy

The search strategy encompassed systematically reviewing peer-reviewed published papers with an initial database search of PsycINFO, CINAHL Complete, ERIC, MEDLINE, and psychARTICLES. This search was undertaken for papers that explored SRL strategies and academic achievement in online higher education settings with the aim of maximising relevant findings for papers published within the last decade. The key terms used are shown in Box 1. This search was performed in Dec 2014.

2.3. Types of studies

All studies were required to examine the application of SRL strategies by students who enrolled in an online or web-based course where the outcome variable was based on academic achievement. Studies involving solely traditional classroom learning, blended/hybrid learning environments, or used combined SRL strategies instead of single strategies were excluded. Self-regulated learning strategies that have been clearly identified within the SRL literature were included.

Box 1
Search terms.

Search terms

1. student
2. pupil
3. scholar
4. university
5. undergrad*
6. postgrad*
7. higher education
8. tafe
9. course
10. tertiary
11. college
12. post secondary education
13. freshman
14. sophomore
15. or/1–14

AND

16. online
17. web based
18. internet
19. distance education
20. computer support*
21. or/16–20

AND

22. self regulat* learning strategy*
23. metacog*
24. learning strategy*
25. self regulat*
26. rehearsal
27. elaboration
28. organisation
29. critical thinking
30. monitoring
31. time management
32. effort regulation
33. peer learning
34. help seeking
35. concentration
36. goal setting
37. environment structur*
38. task strateg*
39. self evaluat*
40. Or/22–39

AND

41. academic outcome
42. academic attainment
43. academic accomplishment
44. academic achievement
45. achievement
46. score
47. mark*
48. rank*
49. GPA
50. grade*
51. success
52. performance
53. Or/43–55
54. 15 and 21 and 40 and 53

2.4. Type of participants

Only studies with university, college or equivalent students as participants were included in this review. Participant gender, race, age, type of course being undertaken and other demographic information were not subject to limitation. Studies where participants were not classified as higher education students were excluded.

2.5. Types of outcome measures

Studies that assessed the influence of SRL strategies on participants' online academic outcomes were incorporated. Online academic outcomes were defined as the achievement of a particular result in an online assignment, exam, subject, or degree and were expressed in terms of a numerical grade or grade point average (GPA). Papers focusing on the impact of SRL strategies on non-academic outcomes were excluded.

2.6. Selection process

Papers were eligible for review if they specifically explored SRL strategies and academic achievement in online or web-based education environments. Papers were excluded if no SRL strategy was examined, where more than one SRL strategy was examined in combination, where the course was not within an online higher education setting and where academic outcome was not operationalized as having achieved a grade, or SRL strategy was not examined in relation to grade. One author (JB) independently screened the titles and abstracts of identified citations for eligibility. Both authors (WP & JB) then examined the full texts of potential papers to identity inclusion eligibility. Where discrepancies arose, discussion was held until consensus was reached.

2.7. Meta-analysis

Effect and sample sizes were extracted from each paper and tabled in SPSS. Although studies varied in the effect size metric used, all effects were converted to *r* values for the present analyses as an easily interpretable metric with good statistical properties (Rosenthal & DiMatteo, 2001). In instances where non-significant effect sizes were not available (from papers or contact with authors), *r* values were set to 0 (Borenstein, Hedges, Higgins, & Rothstein, 2009).

Two approaches were taken to calculate the average effect size. First, a multilevel modelling (MLM) approach was used to derive an estimate of average effect size across all studies and estimates, while controlling for non-independence due to multiples estimates within the same study (e.g., measuring the association between academic performance and SRL strategies; Hox, 2010). Second, single-level meta-analyses were conducted using Field and Gillett's (2010) syntax to calculate the relationship between academic performance and each of the SRL strategies separately. None of the studies had multiple estimates of the same relationship, and therefore MLM was unnecessary.

For both approaches, random-effects modelling was used (Field & Gillett, 2010). Heterogeneity in effect sizes was assessed for the single-level analyses using Cochrane's Q for significance testing and I^2 to indicate level of heterogeneity in interpretable form (Borenstein et al., 2009). I^2 ranges from 0 (no heterogeneity) to 100 (complete heterogeneity across studies), and values greater than 25 suggest sufficient heterogeneity to warrant future consideration of effect size modifiers (e.g., study level differences that may influence obtained effect size). For the MLM, significance was tested using deviance statistics and heterogeneity values were obtained using intra-class correlations (ICC values). Rosenthal's (1979) failsafe *N* calculation was conducted to evaluate publication bias, and does so by indicating how many additional subjects are necessary to render an average effect size non-significant.

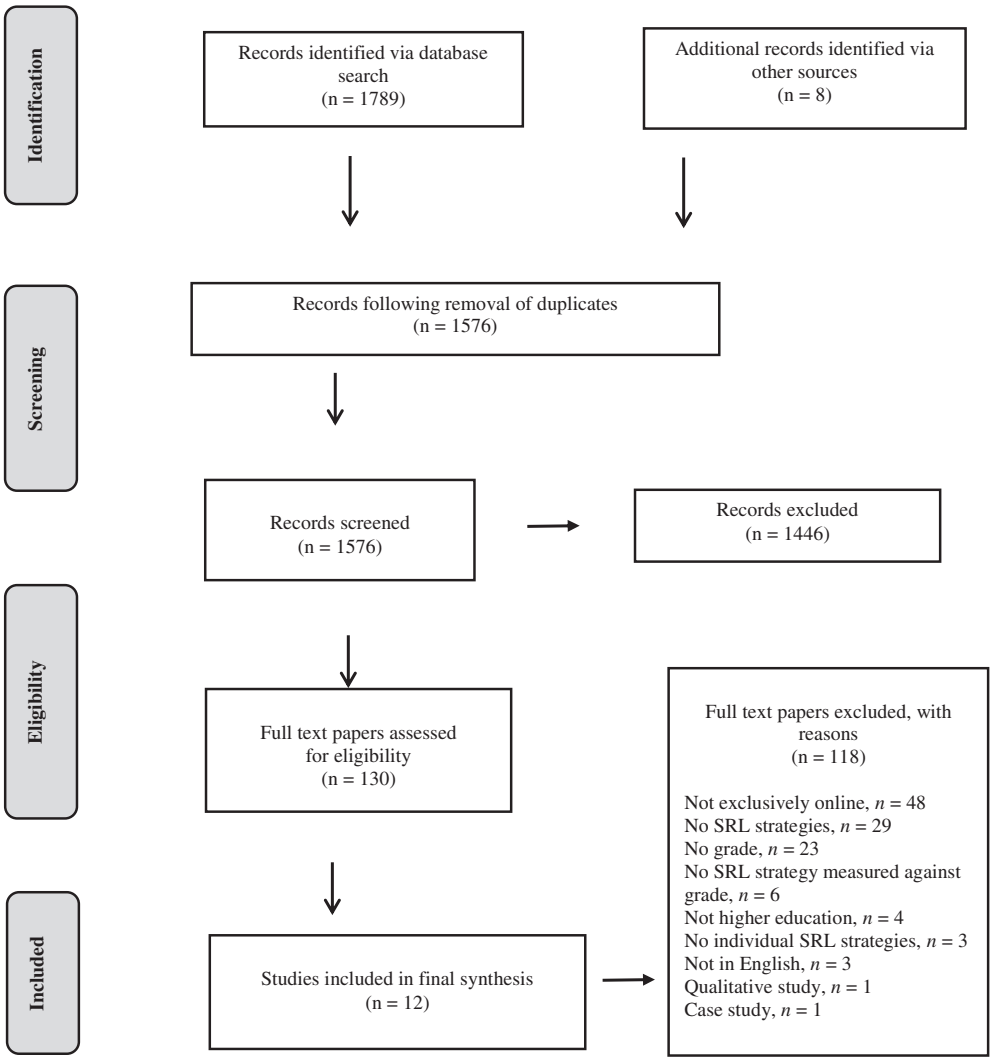

Fig. 1. Flow diagram of papers included in review.

3. Findings

3.1. Description of included papers

The initial database search strategy resulted in 1789 findings; 130 full text articles were assessed for eligibility and ultimately twelve papers remained which were considered relevant for this systematic review. See Fig. 1, which outlines the flow diagram of papers that remained. A full list of included ($n = 12$) and excluded studies ($n = 118$) with reasons for exclusions are found in Tables 1 and 2, respectively. One study (Carson, 2011) was included twice as two different online student cohorts were included in the study. Each of these student cohorts were analysed separately.

3.2. Methodology

The majority of studies were prospective (Carson, 2011; ChanLin, 2012; Cho & Shen, 2013; Hodges & Kim, 2010; Johnson et al., 2009; Michinov et al., 2011; Puzziferro, 2008), followed by experimental (Chang, 2007, 2010; Van den Boom et al., 2007) and cross-sectional (Klingsieck et al., 2012; Wang & Wu, 2008).

The most popular measure used to assess SRL strategy was the Motivated Strategies for Learning Questionnaire (MSLQ) with nine studies (Chang, 2007, 2010; Cho & Shen, 2013; Hodges & Kim, 2010; Johnson et al., 2009; Klingsieck et al., 2012; Puzziferro, 2008; Van den Boom et al., 2007; Wang & Wu, 2008), followed by three studies that measured Learning Management System (LMS) logs (ChanLin, 2012; Johnson et al., 2009; Michinov et al., 2011), one study that measured the Learning and Study Strategies Inventory (LASSI; ChanLin, 2012), and LASSI for online learning (Carson, 2011) and one study that used the Tuckman procrastination scale (Michinov et al., 2011). See Table 1.

3.3. Outcome measures

Of the 11 papers reviewed, only one study used self-reported measures as a definition of academic achievement (Klingsieck et al., 2012). Four studies used a score on an assignment or exam (Chang, 2010; ChanLin, 2012; Hodges & Kim, 2010; Van den Boom et al., 2007), four studies used final subject grade (Chang, 2007; Johnson et al., 2009; Michinov et al., 2011; Puzziferro, 2008) and one study each used final course grade (Cho & Shen, 2013) and GPA (Carson, 2011).

3.4. Self-regulated learning strategies investigated

SRL strategies examined by each study are discussed below and presented in Table 1 and in Fig. 2.

3.4.1. Self-regulated learning strategies combined

All studies were combined to determine the association between of SRL strategies and online academic achievement. Meta-analysis of all

studies showed that SRL strategies were significantly associated with online academic achievement (weighted mean correlation across all effects sizes $r = .13$, [95% confidence interval: .06, .21], $t_{(11)} = 3.76$, $p = .00$). Although the random effect was non-significant ($Z = 1.60$, $p = .11$), the ICC value indicated substantial between study variance in effect size (ICC = .50), warranting exploration of each of the SRLs separately.

3.4.2. Metacognition

Metacognition, a term coined by Flavell (1979) has been described as the awareness and control of mental thoughts. For example, an online learner who becomes confused from the online material consciously goes back and endeavours to figure it out. Ten studies examined the effect of metacognitive strategies on online academic outcomes; four studies found a significant positive relationship (Carson, 2011; Chang, 2007; Puzziferro, 2008), whereas six studies found a non-significant relationship (Chang, 2010; Cho & Shen, 2013; Hodges & Kim, 2010; Johnson et al., 2009; Klingsieck et al., 2012; Van den Boom et al., 2007). Meta-analysis of these studies showed that using metacognitive strategies was significantly but weakly associated with academic achievement (weighted mean correlation $r = .06$, [95% confidence interval: .03, .06], $z = 4.56$, $p = .00$). This weighted average appears to not be representative as there was a moderate level of heterogeneity between studies; $Q_{(df = 9)} = 15.46$, $p = .08$ $I^2 = 41\%$ (see Table 1 for individual study effect sizes). Rosenthal's (1979) failsafe *N* calculation suggested at least another 78 participants with a null effect to render the overall effect non-significant.

3.4.3. Time management

Time management refers to the ability to plan study time and tasks (Effeney, Carroll, & Bahr, 2013). For example, an online learner may schedule a weekly time to read the recommended readings. Six of the studies explored the role of time management/study management in online academic success; five studies found a significant positive relationship (Carson, 2011; ChanLin, 2012; Michinov et al., 2011; Puzziferro, 2008), whereas two studies did not find a significant relationship (Klingsieck et al., 2012). Meta-analysis of these studies showed that using time management was significantly but weakly associated with academic achievement (weighted mean correlation $r = .14$, [95% confidence interval: .12, .16], $z = 13.67$, $p = .00$). There was moderate inter-study variability in effect sizes; $Q_{(df = 5)} = 10.28$, $p = .07$, $I^2 = 51.44\%$ (see Table 1 for individual study effect sizes). Rosenthal's (1979) failsafe *N* calculation suggested at least another 281 number participants with a null effect to render the overall effect non-significant.

3.4.4. Effort regulation

Effort regulation refers to the capacity to persist when confronted with academic challenges (Richardson et al., 2012). For example, when an online learner continues to study even when the learning material is uninteresting. Five studies examined the relationship between effort regulation and academic grades in online learning; four studies found a significant positive relationship (Carson, 2011; Cho & Shen, 2013; Puzziferro, 2008), whereas one study did not find a significant relationship (ChanLin, 2012). Aggregating across all studies, use of effort regulation strategies was significantly but weakly associated with online academic achievement (weighted mean correlation $r = .11$, [95% confidence interval: .09, .13], $z = 10.80$, $p = .00$). This weighted average appears representative as there was negligible heterogeneity between studies; $Q_{(df = 4)} = 6.22$, $p = .18$, $I^2 = 35.71\%$ (see Table 1 for individual study effect sizes). Rosenthal's (1979) failsafe *N* calculation suggested at least another 159 number participants with a null effect to render the overall effect non-significant.

3.4.5. Peer learning

Peer learning can be described as collaborating with other learners in order to aid one's learning (Effeney et al., 2013). For example, an online learner gets together with other online learners to study. Four studies examined the effect of peer learning on academic achievement; all four studies found a significant positive relationship (ChanLin, 2012; Johnson et al., 2009; Michinov et al., 2011; Puzziferro, 2008). Meta-analysis of these studies showed that peer learning was non-significantly but moderately associated with online academic achievement (weighted mean correlation $r = .30$, [95% confidence interval: −.02, .60], $z = 1.86$, $p = .06$). This weighted average appears representative as there was negligible heterogeneity between studies; $Q^2_{(df = 3)} = 1.35$, $p = .72$, $I^2 = 0\%$ (see Table 1 for individual study effect sizes).

3.4.6. Elaboration

Elaboration refers to the ability to fuse new and existing information with the aim of remembering the new material (Richardson et al., 2012). For example, a learner may relate the online material to what he or she already knows. Three studies examined the effect of elaboration on online academic achievement; one study found a weak positive significant relationship (Puzziferro, 2008), whereas two studies did not find a significant relationship (Klingsieck et al., 2012; Wang & Wu, 2008). Overall, elaboration strategies were non-significantly associated with online academic achievement (weighted mean correlation $r = .00$, [95% confidence interval: −.23, .23], $z = .01$, $p = .99$). This weighted average appears representative as there was negligible heterogeneity between studies; $Q_{(df = 2)} = 1.65$, $p = .44$, $I^2 = 0\%$ (see Table 1 for individual study effect sizes).

3.4.7. Rehearsal

Rehearsal refers to learning by repetition (Effeney et al., 2013), such as a learner who listens to an online lecture over and over again. Three studies explored the relationship between rehearsal and online academic achievement; one study found a weak positive significant relationship (Puzziferro, 2008), whereas two studies did not find a significant relationship (Klingsieck et al., 2012; Wang & Wu, 2008). Meta-analysis of these studies showed that rehearsal strategies were non-significantly associated with online academic achievement (weighted mean correlation $r = -.03$, [95% confidence interval: −.19, .13], $z = .33$, $p = .74$). This weighted average appears representative as there was negligible heterogeneity between studies; $Q_{(df = 2)} = 1.40$, $p = .50$, $I^2 = 0\%$ (see Table 1 for individual study effect sizes).

3.4.8. Organisation

Organisation relates to one's ability to highlight main points during learning (Effeney et al., 2013). For example, an online learner draws up charts and tables to organise the online material. Two studies reviewed the effect of organisation on academic performance; one study found a weak positive significant relationship (Puzziferro, 2008), whereas the other study did not find a significant relationship (Klingsieck et al., 2012). Meta-analysis of both studies showed that organisational strategies were non-significantly associated with online academic achievement (weighted mean correlation $r = .00$, [95% confidence interval: −.15, .15], $z = .00$, $p = 1.00$). This weighted average appears representative as there was negligible heterogeneity between studies; $Q_{(df = 1)} = 1.00$, $p = .32$, $I^2 = 0\%$ (see Table 1 for individual study effect sizes).

3.4.9. Critical thinking

Critical thinking refers to the ability to carefully examine learning material (Richardson et al., 2012). For example, an online learner thinks about possible alternatives after reading an online concluding statement. Two studies reviewed the effect of critical thinking on academic performance; one study found a weak positive significant relationship (Puzziferro, 2008), whereas the other study did not find a significant relationship (Wang & Wu, 2008). Meta-analysis of both studies showed that critical thinking strategies were significantly but weakly associated with online academic achievement (weighted mean correlation $r = .07$,

Table 1
Systematic review table (alphabetical according to first author).

No.	Author(s)	Aim(s) of study	SRL strategies	Academic outcome	Participants, method design, course type & duration	Findings
1	Van den Boom, Paas, and van Merriënboer (2007)	Are students' reflective activities, combined with peer or tutor feedback, beneficial for the development of students' SRL and learning outcomes?	Metacognition	End of course exam grade out of 10	$n = 49$ Gender $n = 36$ F/13 M M_{age}: 38.7 years Design: Experimental SRL measure: MSLQ Course type: Introduction to work psychology Course duration: 9 months	No significant correlation for meta-cognition was found. Effect size could not be calculated from the information provided. Authors were contacted.
2a	Carson (2011)	To determine the degree to which the learning strategies subscales of the LASSI for Learning Online (LLO), predicts online students success *in a Training sample*	Effort regulation (measured as concentration) Metacognition (measured as self-testing) Time management	Online grade point average (GPA) of at least 2.0 (equivalent to a letter grade of C and out of a possible 4.0)	$n = 4909$ Gender $n = 3869$ F/1039 M M_{age}: 33.28 years Design: Prospective SRL measure: online LASSI Course type: First year undergraduates Course duration: unknown	Small significant positive correlation between effort regulation and grade ($r = .10$, 95% CI [.07, .13], $v = .00$) metacognition and GPA ($r = .03$, 95% CI [.00, .06], $v = .00$) and time management and grade ($r = .13$, 95% CI [.10, .16], $v = .00$)
2b	Carson (2011)	To determine the degree to which the learning strategies subscales of the LASSI for Learning Online (LLO), predicts online students success in a *Cross validation sample*	Effort regulation (measured as concentration) Metacognition (measured as self-testing) Time management	Online grade point average (GPA) of at least 2.0 (equivalent to a letter grade of C and out of a possible 4.0)	$n = 3203$ Gender $n = 2567$ F/634 M M_{age}: 33.51 years Design: Prospective SRL measure: online LASSI Course type: First year undergraduate Course duration: Unknown	Small significant positive correlation between effort regulation and grade ($r = .12$, 95% CI [.09, .15], $v = .00$) between metacognition and grade ($r = .05$, 95% CI [.02, .09], $v = .00$) time management and grade ($r = .16$, 95% CI [.13, .19], $v = .00$)
3	Chang (2007)	To determine the effects of a self-monitoring strategy on web-based language learning.	Metacognition (measured as monitoring)	Final numerical grade out of 100 (included comprehension test, assignment, & discussion)	$n = 99$ Gender $n =$ Unknown M_{age}: Unknown years Design: Experimental SRL measure: MSLQ Course type: English Course duration: One semester	Medium significant positive correlation between metacognition and grade ($r = .34$, 95% CI [.16, .51], $v = .01$)
4	Chang (2010)	To examine the effect of a self-monitoring strategy on English as first language online learners' academic performance & motivational beliefs	Metacognition (measured as monitoring)	Final numerical test scores of reading comprehension test for an online subject	$n = 90$ Gender $n =$ Unknown M_{age}: 19–22 years Design: Experimental SRL measure: MSLQ Course type: English Course duration: One semester	No significant relationship between metacognition and grade ($r = .18$, 95% CI [−.03, .37], $v = .01$)
5	ChanLin (2012)	Examine the relationship between students study strategies with their learning outcomes and online interaction.	Time Management Peer Learning (measured by discussion board posts) Effort regulation (measured as concentration)	Final grade for a research project (scores ranged 66 to 92)	$n = 118$ Gender $n =$ Unknown M_{age}: years Design: Prospective SRL measure: LASSI/LMS system logs Course type: Media services Course duration: 12 weeks	Small significant positive correlation between peer learning and grade ($r = .22$, 95% CI [.04, .38], $v = .01$) Time Management was found to predict project grade in a multiple regression analysis ($r = .20$, 95% CI [.02, .37], $v = .00$) Effort regulation was not found to predict project grade in a multiple regression analysis ($r = .02$, 95% CI [−.16, .20], $v = .01$)
6	Cho and Shen (2013)	To examine the role of goal orientation & academic self-efficacy in student achievement mediated by effort regulation, metacognitive regulation and interaction regulation in an online course.	Effort regulation Metacognition	Total points of online subject ($M = 282.46$, $SD = 36.65$; range not specified)	$n = 64$ Gender $n = 58$ F/6 M M_{age}: 27.47 years Design: Prospective SRL measure: MSLQ Course type: Intro. Gerontology Course duration: One semester	Medium significant positive correlation between effort regulation and grade ($r = .30$, 95% CI [.06, .51], $v = .02$). There was no significant correlation between metacognition and grade. ($r = .15$, 95% CI [−.10, .38], $v = .02$).

7	Hodges and Kim (2010)	To explore the relationships among self-regulation, self-efficacy and achievement.	Metacognition (measured as self regulation)	Scores on a multiple choice test out of 5 (although may be 15)	$n = 103$ Gender $n = 69$ F/34 M M_{age}: 18.4 years Design: Prospective SRL measure: MSLQ Course type: Algebra and trigonometry Course duration: One semester	In a linear regression metacognitive strategies were not found to predict academic achievement. Effects sizes could not be determined from the information provided. Authors were contacted for information.
8	Johnson, Gueutal, and Falbe (2009)	To investigate a model of e-learning effectiveness which integrates research on metacognitive activity as well as the role of technology and trainee characteristics.	Metacognition Peer learning (measure by online interaction)	Subject grade out of 4 (in increments of approx. .33).	$n = 914$ Gender $n = 424$ F/460 M M_{age}: 23.79 years Design: Prospective SRL measure: MSLQ/LMS system logs Course type: Intro. management information systems Course duration: One semester (15 weeks)	No significant correlation was found between metacognition and grade ($r = .01$, 95% CI [−.06, .08], $v = .00$). Large significant positive correlation between peer learning and grade ($r = .52$, 95% CI [.47, .57], $v = .00$)
9	Klingsieck, Fries, Horz, and Hofer (2012)	To determine the relationship between online students' procrastination and grades, learning strategies & life satisfaction	Time management (measured by procrastination) Elaboration Organisation Rehearsal Metacognition	Self-classified student rating between 1 to 6 of online degree (1 = very good, 6 = not satisfactory)	$n = 425$ Gender $n = 150$ F/275 M M_{age}: 33.1 years Design: Cross-sectional SRL measure: MSLQ and German short scale of Lay's general procrastination scale. Course type: Undergraduate & postgraduate courses Course duration: 8 semesters.	No significant correlation between time management and grade ($r = .03$, 95% CI [−.07, .13], $v = .00$). Note: this has been reversed so that a higher score equals better time management. *From extra information given by authors*: No significant correlation between organisation and grade ($r = -.08$, 95% CI [−.18, .02], $n = 381$, $v = .00$). A significant correlation between elaboration and grade ($r = -.20$, 95% CI [−.30, −.10], $n = 381$, $v = .00$), rehearsal and grade ($r = -.15$, 95% CI [−.25, −.05], $n = 381$, $v = .00$) and metacognition and grade ($r = .09$, 95% CI [−.01, .19], $n = 381$, $v = .00$)
10	Michinov, Brunot, Le Bohec, Juhel, and Delaval (2011)	To examine the specific learner characteristic of time management (procrastination) in online learning	Time management (measured by procrastination) Peer Learning (measured by online participation)	Final numerical grade of online subject out of 20	$n = 40$ Gender $n = 21$ F/19 M M_{age}: 42.3 years Design: Prospective SRL measure: Tuckman procrastination scale/LMS system logs Course type: Environmental course Course duration: 10 weeks	Medium significant negative relationship between time management (procrastination) and grade ($r = .39$, 95% CI [.09, .63], $v = .03$). Note: this has been reversed so that a higher score equals better time management. Medium significant positive relationship between peer learning (participation) and grade ($r = .35$, 95% CI [.04, .60], $v = .03$)
11	Puzziferro (2008)	To examine performance as a function of grade and course satisfaction, students' online technology self-efficacy and self-regulated learning strategies.	Rehearsal Elaboration Organisation Critical thinking Metacognition Time management (Time/study environment) Effort regulation Peer learning Help seeking	Final letter grade of subject (out of 5)	$n = 815$ Gender $n = 652$ F/163 M M_{age}: 29 years Design: Prospective SRL measure: MSLQ Course type: Liberal arts Course duration: One semester	Time management ($r = .15$, 95% CI [.08, .22], $v = .00$) and effort regulation ($r = .16$, 95% CI [.09, .23] $v = 00$) Rehearsal ($r = .06$, 95% CI [.01, .13], $v = .00$), elaboration ($r = .10$, 95% CI [.03, .17], $v = .00$), organisation ($r = .07$, 95% CI [.00, .14], $v = .00$), critical thinking ($r = .07$, 95% CI [.00, .14], $v = .00$), metacognition ($r = .07$, 95% CI [.00, .14], $v = .00$), peer learning ($r = 0.07$, 95% CI [.00, .14], $v = .00$) & help seeking ($r = .09$, 95% CI [.02, .16], $v = .00$) had small significant positive correlations with online final grades.
12	Wang and Wu (2008)	To explores the roles of self-efficacy, student feedback, self-learning strategies, performance & receiving feedback in web based learning	Elaboration Rehearsal Critical thinking	Average score of draft and revised version of an assignment.	$n = 76$ Gender: Unknown M_{age}: Unknown Design: Cross-sectional SRL measure: MSLQ Course type: Educational psychology Course duration: One semester	Elaboration ($r = .13$, 95% CI [−.09, .35], $v = .01$), rehearsal ($r = .02$, 95% CI [−.02, .24], $v = .01$) and critical thinking ($r = .03$, 95% CI [−.02, .25], $v = .00$) did not predict student online academic achievement

Table 2
Excluded studies.

Paper	Exclusion reason
Ameringer, S., Fisher, D., Sreedhar, S., Ketchum, J. M., & Yanni, L. (2012). Pediatric pain management education in medical students: Impact of a web-based module. *Journal of Palliative Medicine*, *15*(9), 978–983.	No SRL strategies
Antonietti, A., Colombo, B., & Lozotsev, Y. (2008). Undergraduates' metacognitive knowledge about the psychological effects of different kinds of computer-supported instructional tools. *Computers in Human Behavior*, *24*(5), 2172–2198.	No SRL strategies
Artino, A. R. (2008). Motivational beliefs and perceptions of instructional quality: Predicting satisfaction with online training. *Journal of Computer Assisted Learning*, *24*(3), 260–270.	No SRL strategies
Artino, A. R., Jr., & Stephens, J. M. (2009). Beyond grades in online learning: Adaptive profiles of academic self-regulation among Naval Academy graduates. *Journal of Advanced Academics*, *20*(4), 568–601.	No SRL strategy measured against grade
Avsec, S., Rihtarsic, D., & Kocijancic, S. (2014). A predictive study of learner attitudes toward open learning in a robotics class. *Journal of Science Education and Technology*, *23*(5), 692–704.	Not higher education
Bannert, M., & Reimann, P. (2012). Supporting self-regulated hypermedia learning through prompts. *Instructional Science*, *40*(1), 193–211.	Not exclusively online
Barnard-Brak, L., Lan, W. Y., & Paton, V. O. (2010). Profiles in self-regulated learning in the online learning environment. *International Review of Research in Open and Distance Learning 11*(1), 61–80.	No SRL strategy measured against grade
Barnard, L., Paton, V., & Lan, W. (2008). Online self-regulatory learning behaviors as a mediator in the relationship between online course perceptions with achievement. *The International Review of Research in Open and Distributed Learning*, *9*(2).	No SRL strategy measured against grade
Barnard-Brak, L., Paton, V. O., & Lan, W. Y. (2010). Self-regulation across time of first-generation online learners. *ALT-J Association for Learning Technology Journal*, *18*(1), 61–70.	No grade
Biesinger, K., & Crippen, K. (2010). The effects of feedback protocol on self-regulated learning in a Web-based worked example learning environment. *Computers & Education*, *55*(4), 1470–1482.	Not exclusively online
Bolliger, D. U., & Des Armier, D., Jr. (2013). Active learning in the online environment: The integration of student-generated audio files. *Active Learning in Higher Education*, *14*(3), 201–211.	No SRL strategies
Brockelman, K. F. (2009). The interrelationship of self-determination, mental illness, and grades among university students. *Journal of College Student Development*, *50*(3), 271–286.	Not exclusively online
Butcher, K. R., & Sumner, T. (2011). Self-directed learning and the sensemaking paradox. *Human-Computer Interaction*, *26*(1–2), 123–159.	Not exclusively online
Chang, M. (2005). Applying Self-Regulated Learning Strategies in a Web-Based Instruction — An Investigation of Motivation Perception. *Computer Assisted Language Learning*, *18*(3), 217–230.	No grade
Chen, C.-M., & Chang, C.-C. (2014). Mining learning social networks for cooperative learning with appropriate learning partners in a problem-based learning environment. *Interactive Learning Environments*, *22*(1), 97–124.	Not higher education
Chen, C. Y., & Pedersen, S. (2012). Learners' internal management of cognitive processing in online learning. *Innovations in Education and Teaching International*, *49*(4), 363–373.	No grade
Cheng, G., & Chau, J. (2013). Exploring the relationship between students' self-regulated learning ability and their ePortfolio achievement. *The Internet and Higher Education*, *17*, 9–15.	Not exclusively online
Cheng, K.-H., Liang, J.-C., & Tsai, C.-C. (2013). University students' online academic help seeking: The role of self-regulation and information commitments. *The Internet and Higher Education*, *16*, 70–77.	No grade
Cho, M.-H., Demei, S., & Laffey, J. (2010). Relationships between self-regulation and social experiences in asynchronous online learning environments. *Journal of Interactive Learning Research*, *21*(3), 297–316.	No grade
Choudhury, B., & Gouldsborough, I. (2012). The use of electronic media to develop transferable skills in science students studying anatomy. *Anatomical Sciences Education*, *5*(3), 125–131.	Not exclusively online
Coll, C., Rochera, M. J., & de Gispert, I. (2014). Supporting online collaborative learning in small groups: Teacher feedback on learning content, academic task and social participation. *Computers & Education*, *75*, 53–64.	No SRL strategies
Cook, D. A., Thompson, W. G., & Thomas, K. G. (2011). The Motivated Strategies for Learning Questionnaire: Score validity among medicine residents. *Medical Education*, *45*(12), 1230–1240.	No SRL strategies
Ćukušić, M., Garača, Ž., & Jadrić, M. (2014). Online self-assessment and students' success in higher education institutions. *Computers & Education*, *72*, 100–109.	No SRL strategies
Dowell, D. J., & Small, F. A. (2011). What is the impact of online resource materials on student self-learning strategies? *Journal of Marketing Education*, *33*(2), 140–148.	No SRL strategies
Edit, W. (2009). Nappali képzésen résztvevő és távoktatásos egyetemi hallgatók iskolai motivációjának, a beteljesülés iskolai késleltetésére való hajlandóságának és tanulási stratégia-alkalmazásának összehasonlítása. = Comparing academic motivation, academic delay of gratification and learning strategy use among on-campus and distance education college students. *Erdélyi Pszichológiai Szemle*, *10*(3), 251–281.	Not in english
Ekahitanond, V. (2013). Promoting university students' critical thinking skills through peer feedback activity in an online discussion forum. *Alberta Journal of Educational Research*, *59*(2), 247–265.	Not exclusively online
Eva, K. W., & Regehr, G. (2011). Exploring the divergence between self-assessment and self-monitoring. *Advances In Health Sciences Education: Theory And Practice*, *16*(3), 311–329.	Not exclusively online
Farajollahi, M., & Moenikia, M. (2011). The effect of computer-based learning on distance learners' self regulated learning strategies. *World Journal on Educational Technology*, *3*(1), 28–38.	No grade
Fraughton, T. B., Sansone, C., Butner, J., & Zachary, J. (2011). Interest and performance when learning online: Providing utility value information can be important for both novice and experienced students. *International Journal of Cyber Behavior, Psychology and Learning*, *1*(2), 1–15.	Not exclusively online
Geddes, D. (2009). How am I doing? Exploring on-line gradebook monitoring as a self-regulated learning practice that impacts academic achievement. *Academy of Management Learning & Education*, *8*(4), 494–510.	Not exclusively online
Ghauth, K. I., & Abdullah, N. A. (2010). Learning materials recommendation using good learners' ratings and content-based filtering. *Educational Technology Research and Development*, *58*(6), 711–727.	No SRL strategies
Gaudreau, P., Miranda, D., & Gareau, A. (2014). Canadian university students in wireless classrooms: What do they do on their laptops and does it really matter? *Computers & Education*, *70*, 245–255.	Not exclusively online
Geçer, A. K. (2014). A study on information search and commitment strategies on web environment and internet usage self-efficacy beliefs of university students. *TOJET: The Turkish Online Journal of Educational Technology*, *13*(2), 1–17.	No SRL strategies
Haigh, M. (2007). Divided by a common degree program? Profiling online and face-to-face information science students. *Education for Information*, *25*(2), 93–110.	No grade
Hauk, S., & Segalla, A. (2005). Student Perceptions of the Web-Based Homework Program WeBWorK in Moderate Enrollment College Algebra Classes. *Journal of Computers in Mathematics and Science Teaching*, *24*(3), 229–253.	Not exclusively online
Hayes, H., & Embretson, S. E. (2013). The impact of personality and test conditions on mathematical test performance. *Applied Measurement in Education*, *26*(2), 77–88.	Not exclusively online
Heinzow, H. S., Friederichs, H., Lenz, P., Schmedt, A., Becker, J. C., Hengst, K., . . . Domagk, D. (2013). Teaching ultrasound in a curricular course according to certified EFSUMB standards during undergraduate medical education: a prospective study. *BMC Medical Education*, *13*, 84–84.	Not exclusively online

Table 2 (*continued*)

Paper	Exclusion reason
Hsieh, P.-H., & Chen, N.-S. (2012). Effects of reflective thinking in the process of designing software on students' learning performances. *TOJET: The Turkish Online Journal of Educational Technology*, *11*(2), 88–99.	Not exclusively online
Huet, N., Escribe, C., Dupeyrat, C., & Sakdavong, J.-C. (2011). The influence of achievement goals and perceptions of online help on its actual use in an interactive learning environment. *Computers in Human Behavior*, *27*(1), 413–420.	No SRL strategies
Husman, J., & Hilpert, J. (2007). The intersection of students' perceptions of instrumentality, self-efficacy, and goal orientations in an online mathematics course. *Zeitschrift für Pädagogische Psychologie/German Journal of Educational Psychology*, *21*(3–4), 229–239.	Not in english
Kauffman, D. F. (2004). Self-regulated learning in web-based environments: Instructional tools designed to facilitate cognitive strategy use, metacognitive processing, and motivational beliefs. *Journal of Educational Computing Research*, *30*(1–2), 139–161.	Not exclusively online
Kauffman, D. F., Zhao, R., & Yang, Y.-S. (2011). Effects of online note taking formats and self-monitoring prompts on learning from online text: Using technology to enhance self-regulated learning. *Contemporary Educational Psychology*, *36*(4), 313–322.	Not exclusively online
Kim, P., Hong, J.-S., Bonk, C., & Lim, G. (2011). Effects of group reflection variations in project-based learning integrated in a Web 2.0 learning space. *Interactive Learning Environments*, *19*(4), 333–349.	Not exclusively online
Kim, M., & Ryu, J. (2013). The development and implementation of a web-based formative peer assessment system for enhancing students' metacognitive awareness and performance in ill-structured tasks. *Educational Technology Research and Development*, *61*(4), 549–561.	Not exclusively online
Kalelioğlu, F., & Gülbahar, Y. (2014). The effect of instructional techniques on critical thinking and critical thinking dispositions in online discussion. *Journal of Educational Technology & Society*, *17*(1), 248–258.	Not exclusively online
Ke, F., Chávez, A. F., Causarano, P.-N. L., & Causarano, A. (2011). Identity presence and knowledge building: Joint emergence in online learning environments? *International Journal of Computer-Supported Collaborative Learning*, *6*(3), 349–370.	No grade
Kim, R., Olfman, L., Ryan, T., & Eryilmaz, E. (2014). Leveraging a personalized system to improve self-directed learning in online educational environments. *Computers & Education*, *70*, 150–160.	No grade
Kitsantas, A., & Chow, A. (2007). College students' perceived threat and preference for seeking help in traditional, distributed, and distance learning environments. *Computers & Education*, *48*(3), 383–395.	No SRL strategy measured against grade
Klinger, T. H. (2006). Learning Approach, Thinking Style and Critical Inquiry: The Online Community. *Korean Journal of Thinking & Problem Solving*, *16*(1), 91–113.	No grade
Knight, J. (2010). Distinguishing the learning approaches adopted by undergraduates in their use of online resources. *Active Learning in Higher Education*, *11*(1), 67–76.	Not exclusively online
Koutsabasis, P., Stavrakis, M., Spyrou, T., & Darzentas, J. (2011). Perceived impact of asynchronous e-learning after long-term use: Implications for design and development. *International Journal of Human-Computer Interaction*, *27*(2), 191–213.	No grade
Kramarski, B., & Michalsky, T. (2009). Three metacognitive approaches to training pre-service teachers in different learning phases of technological pedagogical content knowledge. *Educational Research and Evaluation*, *15*(5), 465–485.	Not exclusively online
Kumrow, D. E. (2007). Evidence-based strategies of graduate students to achieve success in a hybrid Web-based course. *The Journal Of Nursing Education*, *46*(3), 140–145.	Not exclusively online
Lee, B. H., Chae, Y. M., Hokama, T., & Kim, S. (2010). Competency-based learning program in system analysis and design for health professionals. *Asia-Pacific Journal of Public Health*, *22*(3), 299–309.	No SRL strategies
Lee, Y., Choi, J., & Kim, T. (2013). Discriminating factors between completers of and dropouts from online learning courses. *British Journal Of Educational Technology*, *44*(2), 328–337.	No grade
Lee, J.-K., & Lee, W.-K. (2008). The relationship of e-Learner's self-regulatory efficacy and perception of e-Learning environmental quality. *Computers in Human Behavior*, *24*(1), 32–47.	No SRL strategies
Lee, H.-J., & Lee, J. (2012). Who gets the best grades at top universities? An exploratory analysis of institution-wide interviews with the highest achievers at a top Korean university. *Asia Pacific Education Review*, *13*(4), 665–676.	Not exclusively online
Liu, E., & Lee, C. (2013). Using Peer Feedback to Improve Learning via Online Peer Assessment. *Turkish Online Journal Of Educational Technology — TOJET*, *12*(1), 187-199.	Not exclusively online
Lee, T.-H., Shen, P.-D., & Tsai, C.-W. (2008). Enhancing computing skills of low-achieving students via e-learning: a design experiment of Web-based, problem-based learning and self-regulated learning. *Cyberpsychology & Behavior: The Impact Of The Internet, Multimedia And Virtual Reality On Behavior And Society*, *11*(4), 431–436.	No SRL strategies
Liu, Y. (2007). A comparative study of learning styles between online and traditional students. *Journal of Educational Computing Research*, *37*(1), 41–63.	No SRL strategies
Melrose, S. (2006). Facilitating help-seeking through student interactions in a WebCT online graduate study program. *Nursing & Health Sciences*, *8*(3), 175–178.	Qualitative study
Morisano, D., Hirsh, J. B., Peterson, J. B., Pihl, R. O., & Shore, B. M. (2010). Setting, elaborating, and reflecting on personal goals improves academic performance. *Journal of Applied Psychology*, *95*(2), 255–264.	No SRL strategies
Muis, K. R., Ranellucci, J., Franco, G. M., & Crippen, K. J. (2013). The interactive effects of personal achievement goals and performance feedback in an undergraduate science class. *Journal of Experimental Education*, *81*(4), 556–578.	Not exclusively online
Nemati, H., & Thompson, M. (2009). Factors influencing students intention to take web-based courses in a college environment. *International Journal of Information and Communication Technology Education*, *5*(3), 83–93.	No grade
Nere, S. N., Fernandez, E., Feldhaus, C., & Goodwin, J. (2012). Effectiveness of Web-Based Tutorials: Performance on Statistical Concepts. *GSTF Journal on Computing*, *1*(4), 88–95.	No SRL strategies
Nokelainen, P., Miettinen, M., Kurhila, J., Floréen, P., & Tirri, H. (2005). A shared document-based annotation tool to support learner-centred collaborative learning. *British Journal of Educational Technology*, *36*(5), 757–770.	Not exclusively online
O'Bannon, B. W., Bntt, V. G., & Beard, J. L. (2014). The writing on the wall: Using a Facebook group to promote student achievement. *Journal of Educational Multimedia and Hypermedia*, *23*(1), 29–54.	No SRL strategies
Paechter, M., Maier, B., & Macher, D. (2010). Students' expectations of, and experiences in e-learning: Their relation to learning achievements and course satisfaction. *Computers & Education*, *54*(1), 222–229.	No grade
Pittenger, A. L., & Lounsbery, J. L. (2011). Student-generated questions to assess learning in an online orientation to pharmacy course. *American Journal Of Pharmaceutical Education*, *75*(5), 94–94.	No SRL strategies
Powell, S., Tindal, I., & Millwood, R. (2008). Personalized learning and the ultraversity experience. *Interactive Learning Environments*, *16*(1), 63–81.	No grade
Proske, A., Narciss, S., & Körndle, H. (2007). Interactivity and learners' achievement in web-based learning. *Journal of Interactive Learning Research*, *18*(4), 511–531.	Not exclusively online
Raska, D. (2014). Excited, proud, and accomplished: Exploring the effects of feedback supplemented with web-based peer benchmarking on self-regulated learning in marketing classrooms. *Journal of Marketing Education*, *36*(3), 258–271.	Not exclusively online
Rouis, S., Limayem, M., & Salehi-Sangari, E. (2011). Impact of Facebook usage on students' academic achievement: Role of self-regulation and trust. *Electronic Journal of Research in Educational Psychology*, *9*(3), 961–994.	Not exclusively online
Samruayruen, B., Enriquez, J., Natakuatoong, O., & Samruayruen, K. (2013). Self-regulated learning: A key of a successful learner in online learning environments in Thailand. *Journal of Educational Computing Research*, *48*(1), 45–69.	Not exclusively online

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Table 2 (*continued*)

Paper	Exclusion reason
Sansone, C., Fraughton, T., Zachary, J. L., Butner, J., & Heiner, C. (2011). Self-regulation of motivation when learning online: The importance of who, why and how. *Educational Technology Research and Development*, *59*(2), 199–212.	Not exclusively online
Sathler, T. C., & Fleith, D. d. S. (2010). Estímulos e barreiras à criatividade na educação a distância. = Incentives and barriers to creativity in the context of distance learning. *Estudos de Psicologia*, *27*(4), 457–466.	Not in english
Schoor, C., & Bannert, M. (2012). Exploring regulatory processes during a computer-supported collaborative learning task using process mining. *Computers in Human Behavior*, *28*(4), 1321–1331.	Not exclusively online
Şendağa, S., & Odabaşi, H. F. (2009). Effects of an online problem based learning course on content knowledge acquisition and critical thinking skills. *Computers & Education*, *53*(1), 132–141.	No SRL strategies.
She, H.-C., Cheng, M.-T., Li, T.-W., Wang, C.-Y., Chiu, H.-T., Lee, P.-Z., . . . Chuang, M.-H. (2012). Web-based undergraduate chemistry problem-solving: The interplay of task performance, domain knowledge and web-searching strategies. *Computers & Education*, *59*(2), 750–761.	Not exclusively online
Shea, P., & Bidjerano, T. (2012). Learning presence as a moderator in the community of inquiry model. *Computers & Education*, *59*(2), 316–326.	No grade
Shinkareva, O. N., & Benson, A. D. (2007). The relationship between adult students' instructional technology competency and self-directed learning ability in an online course. *Human Resource Development International*, *10*(4), 417–435.	No grade
Sitzmann, T., Bell, B. S., Kraiger, K., & Kanar, A. M. (2009). A multilevel analysis of the effect of prompting self-regulation in technology-delivered instruction. *Personnel Psychology*, *62*(4), 697–734.	No SRL strategies.
Sitzmann, T., Ely, K., Bell, B. S., & Bauer, K. N. (2010). The effects of technical difficulties on learning and attrition during online training. *Journal of Experimental Psychology: Applied*, *16*(3), 281–292.	Not higher education
Sitzmann, T., & Johnson, S. K. (2012). The best laid plans: Examining the conditions under which a planning intervention improves learning and reduces attrition. *Journal of Applied Psychology*, *97*(5), 967–981.	Not higher education
Smith, J., Wilson, S. B., Banks, J., Zhu, L., & Varma-Nelson, P. (2014). Replicating Peer-Led Team Learning in cyberspace: Research, opportunities, and challenges. *Journal of Research in Science Teaching*, *51*(6), 714–740.	No SRL strategies.
Spence, D. J., & Usher, E. L. (2007). Engagement with mathematics courseware in traditional and online remedial learning environments: Relationship to self-efficacy and achievement. *Journal of Educational Computing Research*, *37*(3), 267–288.	No SRL strategies.
Sowan, A. K., & Jenkins, L. S. (2013). Designing, delivering and evaluating a distance learning nursing course responsive to students needs. *International Journal Of Medical Informatics*, *82*(6), 553–564.	No SRL strategies.
Susser, J. A., & McCabe, J. (2013). From the lab to the dorm room: Metacognitive awareness and use of spaced study. *Instructional Science*, *41*(2), 345–363.	Not exclusively online
Tinocaa, L., & Oliveira, I. (2013). Formative assessment of teachers in the context of an online learning environment. *Teachers and Teaching: Theory and Practice*, *19*(2), 214–227.	No grade
Tsai, C.-W. (2011). Achieving effective learning effects in the blended course: a combined approach of online self-regulated learning and collaborative learning with initiation. *Cyberpsychology, Behavior And Social Networking*, *14*(9), 505–510.	Not exclusively online
Tsai, C.-W. (2013). An effective online teaching method: The combination of collaborative learning with initiation and self-regulation learning with feedback. *Behaviour & Information Technology*, *32*(7), 712–723.	Not exclusively online
Tsai, C.-W., Hsu, P.-F., & Tseng, H.-J. (2013). Exploring the effects of web-mediated game-based learning and self-regulated learning on students' learning. *International Journal of Information and Communication Technology Education*, *9*(2), 39–51.	Not exclusively online
Tsai, C.-W., & Lee, T.-H. (2012). Developing an appropriate design for e-learning with web-mediated teaching methods to enhance low-achieving students' computing skills: Five studies in e-learning implementation. *International Journal of Distance Education Technologies*, *10*(1), 1–30.	Not exclusively online
Tsai, C.-W., & Shen, P.-D. (2009). Applying web-enabled self-regulated learning and problem-based learning with initiation to involve low-achieving students in learning. *Computers in Human Behavior*, *25*(6), 1189–1194.	Not exclusively online
Tsai, C.-W., & Shen, P.-D. (2011). The application of web and educational technologies in supporting web-enabled self-regulated learning in different computing course orientations. *International Journal of Information and Communication Technology Education*, *7*(1), 70–79.	No SRL strategies
Tseng, J.-L., & Pai, I.-C. (2012). Analyzing the Learning Modes of Learners using Time-Management Modules in Self-Paced Learning. *GSTF Journal on Computing*, *2*(3), 53–58.	No SRL strategies
Tuckman, B. W. (2005). Relations of academic procrastination, rationalizations, and performance in a web course with deadlines. *Psychological Reports*, *96*(3 Pt 2), 1015–1021.	Not exclusively online
Virtanen, P., & Nevgi, A. (2010). Disciplinary and gender differences among higher education students in self-regulated learning strategies. *Educational Psychology*, *30*(3), 323–347.	No grade
Wang, Y., Peng, H., Huang, R., Hou, Y., & Wang, J. (2008). Characteristics of distance learners: Research on relationships of learning motivation, learning strategy, self-efficacy, attribution and learning results. *Open Learning: The Journal of Open and Distance Learning*, *23*(1), 17–28.	No individual SRL strategies
Wang, C.-H., Shannon, D. M., & Ross, M. E. (2013). Students' characteristics, self-regulated learning, technology self-efficacy, and course outcomes in online learning. *Distance Education*, *34*(3), 302–323.	No individual SRL strategies
Wäschle, K., Allgaier, A., Lachner, A., Fink, S., & Nückles, M. (2014). Procrastination and self-efficacy: Tracing vicious and virtuous circles in self-regulated learning. *Learning and Instruction*, *29*, 103–114.	Not exclusively online
Whipp, J. L., & Chiarelli, S. (2004). Self-Regulation in a Web-Based Course: A Case Study. *Educational Technology Research And Development*, *52*(4), 5–22.	No grade
Whipp, J. L. and R. A. Lorentz (2009). Cognitive and Social Help Giving in Online Teaching: An Exploratory Study. *Educational Technology Research and Development 57*(2): 169–192.	Not exclusively online
Williams, S. L., & Kim, J. (2011). E-mentoring in online course projects: Description of an E-mentoring scheme. *International Journal of Evidence Based Coaching and Mentoring*, *9*(2), 80–95.	No SRL strategies
Xiao, J. (2014). Learner agency in language learning: The story of a distance learner of EFL in China. *Distance Education*, *35*(1), 4–17.	Case study
Xie, K., & Ke, F. (2011). The role of students' motivation in peer-moderated asynchronous online discussions. *British Journal of Educational Technology*, *42*(6), 916–930.	No grade
Yang, C., & Chang, Y. S. (2012). Assessing the effects of interactive blogging on student attitudes towards peer interaction, learning motivation, and academic achievements. *Journal of Computer Assisted Learning*, *28*(2), 126–135.	Not exclusively online
Yang, Y., & Taylor, J. (2013). The role of achievement goals in online test anxiety and help-seeking. *Educational Research and Evaluation*, *19*(8), 651–664.	No grade
Yeh, H.-C., & Yang, Y.-F. (2011). Metacognitive process in online text construction. *Journal of Educational Technology & Society*, *14*(3), 82–101.	No SRL strategy measured against grade
Yen, C.-J., & Abdous, M. h. (2011). A study of the predictive relationships between faculty engagement, learner satisfaction and outcomes in multiple learning delivery modes. *International Journal of Distance Education Technologies*, *9*(4), 57–70.	No SRL strategies
Yukselturk, E. and Bulut, S. (2007). Predictors for student success in an online course. *Educational Technology & Society 10*(2), 71–83.	No individual SRL strategies
Yukselturk, E., & Top, E. (2013). Exploring the link among entry characteristics, participation behaviors and course outcomes of online learners: An examination of learner profile using cluster analysis. *British Journal of Educational Technology*, *44*(5), 716–728.	No SRL strategy measured against grade

Table 2 (*continued*)

Paper	Exclusion reason
Zhou, M. (2013). Using traces to investigate self-regulatory activities: A study of self-regulation and achievement goal profiles in the context of web search for academic tasks. *Journal of Cognitive Education and Psychology*, *12*(3), 287–305.	No grade
Zhao, K., & Chan, C. K. K. (2014). Fostering collective and individual learning through knowledge building. *International Journal of Computer-Supported Collaborative Learning*, *9*(1), 63–95.	Not exclusively online
Zheng, R. Z., Flygare, J. A., & Dahl, L. B. (2009). Style matching or ability building? An empirical study on FD learners' learning in well-structured and ill-structured asynchronous online learning environments. *Journal of Educational Computing Research*, *41*(2), 195–226.	No SRL strategies
Zhu, C., Valcke, M., Schellens, T., & Li, Y. (2009). Chinese students' perceptions of a collaborative e-learning environment and factors affecting their performance: Implementing a Flemish e-learning course in a Chinese educational context. *Asia Pacific Education Review*, *10*(2), 225–235.	Not exclusively online
Zou, X., & Zhang, X. (2013). Effect of different score reports of Web-based formative test on students' self-regulated learning. *Computers & Education*, *66*, 54–63.	Not exclusively online
Zhu, C., Valcke, M., Schellens, T., & Li, Y. (2009). Chinese Students' Perceptions of a Collaborative E-Learning Environment and Factors Affecting Their Performance: Implementing a Flemish E-Learning Course in a Chinese Educational Context. *Asia Pacific Education Review*, *10*(2), 225–235.	Not exclusively online

[95% confidence interval: .00, .13], $z = 2.00$, $p = .047$). This weighted average appears representative as there was negligible heterogeneity between studies; $Q_{(df = 1)} = .11$, $p = .74$, $I^2 = 0\%$ (see Table 1 for individual study effect sizes).

3.4.10. Help seeking

Help seeking relates to obtaining assistance from instructors with the aim of overcoming academic challenges (Richardson et al., 2012), such as when an online learner emails their instructor seeking clarification of the learning material. As only one study looked at the relationship between help seeking strategies and online found a weak significant association between help seeking and online achievement ($r = .09$, 95% CI [.02, .16]; Puzziferro, 2008).

4. Discussion

We synthesised the last 10 years of research into the association between SRL strategies and student academic achievement in higher education courses that were taught wholly online. This systematic review found that nine SRL strategies had been investigated in relation to academic achievement in online learners in higher education: metacognition, time management, effort regulation, peer learning, elaboration, rehearsal, organisation, critical thinking, and help seeking. Of these, help seeking was not meta-analysed separately, as it was covered by a single study.

The meta-analysis revealed that only four of the remaining eight learning strategies were significantly associated with academic achievement. Metacognition, time management, effort regulation, and critical thinking were found to be significantly but weakly associated with academic achievement; weighted mean correlations (r) ranged from .05 to .14. While these are small correlations, they should not be overlooked if they have population relevant effects (Richardson et al., 2012). These findings suggest that online students who make good use of their time, are conscious of their learning behaviour, are critical in their examination of content, and persevere in understanding the learning material despite challenges faced are more likely to achieve higher academic grades in online settings.

Present effect sizes are congruent with, albeit smaller than, those previously found in the traditional classroom. Richardson et al. (2012) conducted a meta-analysis on the relationship between SRL strategies and academic performance within higher education settings found that effort regulation ($r = .32$, 95% CI [.29, .35]), time management ($r = .22$, 95% CI [.14, .29]), metacognition ($r = .18$, 95% CI [.10, .26]), and critical thinking ($r = .15$, 95% CI [.11, .18]), were some of the strongest correlates of academic success. The smaller effect sizes found for online students may be explained in several ways. First, the effects of these strategies (and perhaps all SRL strategies) are potentially

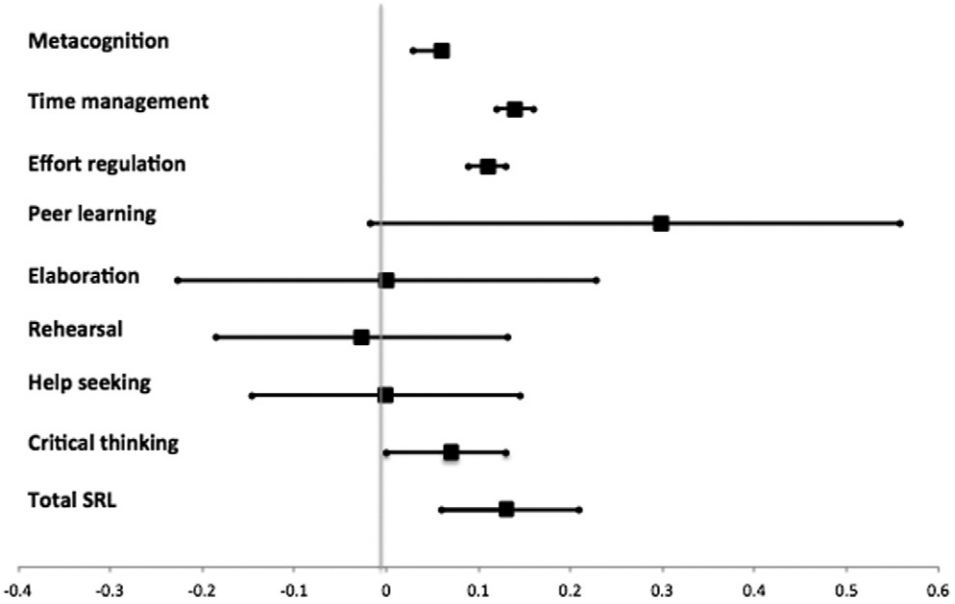

Fig. 2. Forest plot of each individual SRL strategy and the combined SRL strategies.

dampened in the online learning environment. Second, we should not assume that online learning in itself fosters SRL strategies use or development. Nor should we assume that transferring traditional teaching design and material to the online learning environment will necessarily result in the same learning outcomes. Teachers should ensure they fully utilise the benefits afforded by online environments, such as flexibility, while carefully designing for the development of self-regulatory skills.

Despite the difference in effect sizes, when combined, the findings of both reviews suggest that the application of time management, effort regulation, critical thinking and metacognitive strategies leads to higher academic outcomes within both online and traditional higher education environments. Importantly, this highlights that both online and traditional students should apply these four strategies in order to increase the likelihood of academic success.

Another interesting observation from the present review is that the strongest effect was found for peer learning. Although three of the four studies found moderate to strong effect sizes, the overall meta-analysis was non-significant ($p = .06$) because one large study (Puzziferro, 2008) with a weak positive correlation exerted downward pressure on the weighted effect size. Further exploration of the Puzziferro (2008) study showed it differed from the others in operationalization of peer learning. Puzziferro (2008) measured peer learning via survey using the MSLQ, whereas the remaining three studies tracked students' peer interactions using LMS logs. Arguably, LMS logs of discussion board activity may be a better measure of peer learning in the online environment than measures created for the traditional classrooms (such as the MSLQ). For instance, the MSLQ includes questions that tap into behaviours that are not common/possible for online students, whereas logs of LMS use are pertinent because this is the main form of communication for online students. Consequently, we contend that the Puzziferro study may be less representative of the peer learning and performance relationship, and argue that peer learning should also be prioritised in the context of online learning despite the borderline statistical significance obtained in this review for this relationship.

Interestingly, from the three remaining studies that measured peer learning via LMS logs, it is possible that peer learning occurs (and enhances performance) when students are both actively and passively participating in peer learning via the discussion boards. Both ChanLin (2012) and Michinov et al. (2011) reported active peer learning by measuring the number of student discussion posts, and found small to moderate effects sizes ($r = .22$ and .35, respectively). However, the inclusion of passive activities such as number of discussion posts read by students (in combination with posts created and posts replied) led to a large effect size ($r = .52$) between academic achievement and peer learning (Johnson et al., 2009). This finding indicates that passive behaviour, such as reading discussion posts, may also be a good predictor of performance. Certainly, studies of academic achievement and discussion board activity support this assertion (Gašević, Dawson, & Siemens, 2015; Morris, Finnegan, & Sz-Shyan, 2005). These findings are also considerably stronger than those found by Richardson et al. (2012) in face-to-face teaching contexts, suggesting that possibly peer learning is less important in the traditional face-to-face classroom, where there is also more interaction with teaching staff. For online students however, where interaction with teaching staff may be reduced, students may seek to use alternatives that are more available (i.e., peers) to get assistance. This may contribute to increased importance of peer learning in online settings compared to traditional classrooms.

Future studies into peer learning and academic achievement in the online environment should consider: (1) using measures other than those used in the traditional classroom, such as discussion board activity, and (2) including both passive and active behaviour on the discussion board. While increasing students' use of peer learning is a challenge in online learning environments, students should be encouraged to participate (either passively or actively) on the discussion boards.

Lastly, the present meta-analysis revealed that the cognitive strategies of elaboration, rehearsal, and organisation were not related to online academic achievement. Only one study found that each of these strategies had a weak positive significant relationship with academic achievement (Puzziferro, 2008); the remaining two studies found no association (Klingsieck et al., 2012; Wang & Wu, 2008). These null results accord with Richardson et al.'s (2012) findings found that rehearsal ($r = .01$, 95% CI [−.07, .10]) and organisation ($r = .04$, 95% CI [−.06, .15]) were not significantly related to academic achievement in traditional classroom contexts. However, elaboration had a small positive relationship to GPA ($r = .18$, 95% CI [.11, .24]). Strategies such as rehearsal are thought to be superficial surface level strategies that do not provide rich learning (Pintrich, 2000). Elaboration, on the other hand, is thought to be a higher-level strategy that involves deeper processing of information. While this technique seems to be useful in the traditional classroom, it appears to be less useful in the online environment. The results suggest that online learners should not dedicate time to using elaboration, rehearsal, and organising when learning new material as these strategies may not increase the likelihood of academic success.

4.1. Limitations

This review has several limitations. First, several reported effects found in the present review were variable across studies, in particular metacognition, time management, effort regulation, and SRL strategies combined. While sample size (number of papers) precluded this possibility here, ordinarily a meta-regression would be conducted to identify moderators of the strength of association between SRL and achievement. As discussed above, study design and measure of academic achievement are potential moderators of this relationship. As research in the area of SRL in online learning environment increases, future studies should further explore these and other potential moderators to determine whether any are involved in the SRL strategy –academic achievement relationship.

Second, one should be mindful about the 'traditional' measures being used by many of the studies in this review. While these measures are suitable for the traditional face-to-face classroom, they may not translate to how students learn in the online environment. For example, nine of the 12 studies included in the review used the MSLQ. Although the MSLQ has been found to have strong reliability and sound validity (Pintrich, Simith, Garcia, & McKeachie, 1993; Pintrich, Smith, Garcia, & McKeachie, 1991), the validation of this measure has been within traditional face-to-face higher educational settings. In a different learning context such as the online environment, this measure may not capture the construct of online learner self-regulation as accurately as online-focused, validated measures.

Third, although academic achievement was operationalized as the online student grade on an assignment, subject, or GPA by all studies reviewed, one study permitted the use of grades reported by students themselves in place of actual grades received (Klingsieck et al., 2012). Some studies have shown that students may overstate their own grades due to social desirability reporting, especially by those who in fact performed at a lower level and this consequently can affect the construct validity of results (Kuncel, Credé, & Thomas, 2005). This may be a possible reason for the non-significant results found for all strategies (time management elaboration, organisation, rehearsal, metacognition) in the Klingsieck et al. (2012) study. When measuring online academic outcomes, future research should utilise actual student online grades rather than student reported online grades in order to eliminate social desirability bias.

Lastly, although this review demonstrates that some individual SRL strategies are related to academic performance, the underlying processes responsible for this association remain unclear. While examination of potential mechanisms for this association is beyond the scope of the present review, future research should explore this issue. Such explanations should incorporate the observation that SRL strategies are rarely used in isolation, and are more likely to be a part of a larger self-regulated learning process. In particular, equal attention should be paid to exploring how

moderating factors work together with SRL strategies to influence academic achievement in online learning environments. This is especially important since the awareness alone of SRL strategies has been shown to be insufficient to ensure academic success (Artino & Stephens, 2009; Wang et al., 2013), which suggests there are pivotal constructs underlying the process to which students self-regulate. Furthermore, there may be several other mediating factors such as motivation or self-efficacy, which combined with strategy use effect SRL. By identifying such factors, both instructors and online students can work to modify and improve SRL strategy use, in order to achieve higher academic learning outcomes.

4.2. Conclusion

Given the rapid growth of online learning in the last decade, there is a need to understand how students can best utilise SRL strategies to achieve academic success within online environments. Self-regulated learning strategies of time management, metacognition, critical thinking, and effort regulation were found to have significant positive correlations with academic success in online settings, albeit these effect sizes were smaller than those found in the traditional classroom. In contrast, rehearsal, organisation, and elaboration were found to be the least empirically supported SRL strategy within the online environment, indicating that there is less benefit in these strategies for online learners. Lastly, we argue that increased peer learning should be prioritised in the context of online learning and that further research is needed to determine an appropriate measure of this strategy. Future research would benefit from exploring how mediating factors (such as motivation) work together with SRL strategies to improve our understanding of the influence of learner self-regulation on academic success within the online environment.

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