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A comparison of high and low achieving students on self-regulated learning variables

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ABSTRACT

Prior research has established the importance of self-regulated learning (SRL) skills for academic achievement. However, efforts to identify and subsequently remediate students' SRL in classroom contexts are still in the early stages of development. This study sought to examine individual differences in low and high achieving college students ($N = 41$) in a classroom-based context in order to begin to inform remediation and intervention efforts. Results indicated no initial differences between high and low achieving students on prior knowledge, general ability, or self-efficacy. However, important differences emerged on metacognitive monitoring, reported use of low-level study strategies, and self-efficacy over the duration of the course. Test performance measured early in the course, but not baseline measures of SRL components or prior knowledge, was predictive of summative course achievement. Self-report measures of SRL did not align with measures of achievement, monitoring judgments, or interview data, indicating that these measures should be used with caution when examining SRL skills in college classroom contexts. Implications related to the development SRL skills are discussed.

1. Introduction

An emphasis on passive memorization and the recitation of factual information is no longer accepted within instructional contexts. Instead, the focus has shifted to equipping students to become self-regulated, lifelong learners (Cohen, 2012; Luftenegger et al., 2012; Winne, 2013). Contemporary learners encounter greater volumes of information in shorter time frames, increasing their need to efficiently and effectively take in new information (Bembenutty, Cleary, & Kitsantas, 2013; Cohen, 2012; Winne, 2013). Individuals who are self-regulated have the skills necessary to monitor and control their learning, adjusting to the changing demands in their learning environment (Cohen, 2012; Wolters, 2003, 2004; Wolters & Pintrich, 2001; Zimmerman, 2008). Although research efforts have confirmed the importance of self-regulated learning (SRL), more clarification is needed with regard to individual differences in SRL between students who are more versus less successful in classroom contexts. Moreover, an understanding of the alignment of various measurement approaches and the ability of such approaches to predict achievement is also still needed. As researchers attempt to define and facilitate the processes that encourage effective self-regulation, it is important to determine where to focus these efforts.

The current study tracked students through a semester long college course with embedded SRL activities that were intended to simultaneously encourage and assess SRL. These activities included the setting, tracking, and revising of course goals, performance monitoring judgments, as well as the reporting of cognitive strategy use and self-efficacy. The goal of this process was to identify important differences and changes in SRL between high- and low-performing students in order to better understand the dynamics of SRL skills in a classroom context.

2. Relevant literature

2.1. Research in self-regulated learning

SRL can be described as the effective regulation of one's own learning in the pursuit of personal goals (Nietfeld, Shores, & Hoffmann, 2014). According to Zimmerman and Campillo's (2003) social cognitive model, metacognition, motivation, and learner behaviors are the three key components of SRL that influence achievement (Zimmerman & Moylan, 2009). Winne and Hadwin's (1998) information-processing based model of self-regulation relies heavily on metacognitive monitoring and control as the hub of SRL processes. The current study is theoretically situated as a combination of both the social-cognitive and information-processing perspectives as it focuses on the interplay between the metacognitive regulation strategies and motivational variables, i.e., beliefs, goals, and interests (Pintrich, 2000; Winne & Hadwin, 1998; Zimmerman, 2000). Research shows that students who

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can self-regulate their learning processes have higher levels of achievement (Pintrich & De Groot, 1990; Zimmerman, 1990, 2008). Students, however, vary greatly in their ability to regulate their own learning.

Over the past three decades, understanding and improving SRL has emerged as an important area in the study of learning (Bembenutty, 2011; Dinsmore, Alexander, & Loughlin, 2008; Hacker, Dunlosky, & Graesser, 2009; Schunk & Zimmerman, 2008; Winne & Perry, 2000; Zimmerman & Schunk, 2011). Numerous research studies have focused on improving SRL through classroom based interventions (e.g., Ames & Archer, 1988; Bembenutty et al., 2013; Pintrich & De Groot, 1990; Sinkavich, 1991; Waters & Schneider, 2010; Wolters & Pintrich, 2001). For instance, one college-based intervention was aimed at improving struggling students' metacognitive calibration and motivation by assisting students to interpret grades as feedback for improvement, rather than signs of failure (Zimmerman & Moylan, 2009). This intervention employed frequent short quizzes to provide feedback and allowed participants to make corrections, guiding them in self-reflection. Participants in the experimental group outperformed control participants and were more calibrated on pre-task judgments. In another classroom intervention study, Cao and Nietfeld (2007a) reported that college students' awareness of the difficulties in learning the class content, poor test performance, and exposure to various study strategies did not influence their subsequent strategy use, as students continued to implement ineffective study strategies. Students' habitual use of ineffective strategies presents challenges to interventions designed to improve SRL. This finding suggests that self-report metacognitive awareness does not automatically lead to utilization of metacognitive strategies.

One potential approach to better understand how to improve SRL is to compare the relevant characteristics of high and low achieving students (Nandagopal & Ericsson, 2012). Following this approach, Proctor, Prevatt, Adams, and Reaser (2006) compared normal-achieving and academically struggling college students on self-reported study skills. Using the Learning and Study Strategies Inventory (LASSI; Weinstein & Palmer, 2002), Proctor et al., found that students with low GPAs struggled with study skills and scored lower than those with high GPAs on several sub-scales including anxiety, attitude, concentration, information processing, motivation, selecting main ideas, time management, and test strategies. Similar results were found in several other comparisons of different student groups (e.g., learning disabled vs. non-learning disabled, clinic referred vs. not referred), indicating that remediation in these areas could be advantageous for low performing students. Yip (2007, 2009) also compared high and low achieving college students in their use of study strategies. In one study (Yip, 2007) students from Hong Kong were administered a reduced version of the LASSI to identify differences between the high and low achieving students. Results showed a significant difference between the two groups on nine of the ten sub-scales (anxiety was not significantly different). Yip (2009) repeated this study using distance education students and found significant differences between high and low achieving students on all ten sub-scales. Finally, Nandagopal and Ericsson (2012) examined college students majoring in bioscience and found that those with higher pre-existing grade-point averages did not spend more time studying but rather reported using a wider variety of study strategies including high-level approaches that emphasized the organization and transformation of knowledge while learning.

While these studies increased our understanding of the motivation and strategy use between the high and low achieving students, both Proctor et al.'s and Yip's studies were limited in the use of a single self-report measure of SRL at a single time point. Additionally, the LASSI was administered in the Proctor et al. (2006) study as part of an external study that was seemingly unrelated to the courses or programs in which students were enrolled. Nandagopal and Ericsson (2012) used a more longitudinal approach having students record daily study journals, however their reference point for achievement was prior coursework and their focus did not include motivational or metacognitive variables. It is promising to find significant differences between high and low achieving students of various groups in multiple studies. Yet, these studies lacked the direct comparison of achievement and SRL variables over time within an ongoing classroom context. A variety of measures taken within the context of one specific course could help to more clearly identify the SRL-related differences between these groups and inform future interventions. The present study addressed these issues by examining the differences between high and low achieving students on several class content specific measures related to the course in which their achievement groupings are determined. Additionally, a variety of SRL components (e.g. metacognition, motivation, cognitive strategies, goal setting) were measured repeatedly to create a broad picture of learners in the classroom.

2.2. The role of metacognition in SRL

Originally described by Flavell (1979), metacognition, or knowledge of one's own thinking processes, is a vital component of learning and an important characteristic of SRL. Metacognition is a higher order cognitive process that is generally divided into one's knowledge of cognition and regulation of cognition (Baker & Brown, 1984; Schraw & Moshman, 1995). Having knowledge of cognition means learners understand "their own memories and the way they learn," while regulating cognition describes "how well learners can regulate their own memory and learning" (Sperling, Howard, Staley, & DuBois, 2004, p. 118). Research has shown that learners with high levels of metacognitive skills have advantages in reading comprehension (Bouffard-Bouchard, 1994), writing (Graham, Harris, & Olinghouse, 2007), and problem solving (McCormick, 2003), and obtain higher levels of achievement (Cleary & Zimmerman, 2001; Dembo & Seli, 2012; Tobias & Everson, 2009; Zimmerman, 1990; Zimmerman & Schunk, 2011).

Metacognition is pervasive throughout models of SRL (Butler & Winne, 1995; Pintrich, 2000). During the forethought, performance, and self-reflection phases of SRL, metacognitive processes control learner choices and manage learning outcomes (Zimmerman & Moylan, 2009). This higher order process coordinates learning by planning, monitoring, and evaluating cognitive processes (Schraw & Moshman, 1995). Metacognition is difficult to "capture," and is measured through a variety of approaches including but not limited to self-reports, observational methods, think alouds, eye-tracking methods, trace data, and monitoring judgments. Monitoring judgments collected by means of confidence judgments were utilized in the current study. These judgments can be taken in real-time during a test or task and can then be transformed into calibration scores that measure the match between one's perception of performance and their actual level of performance (Dunlosky & Metcalfe, 2009; Nietfeld, Cao, & Osborne, 2006). Generally, research has shown that individuals who can accurately judge their learning are more effective learners (Zimmerman & Moylan, 2009) and this is reflected in relationships between academic performance and accuracy in judgments (Nietfeld & Cao, 2005).

2.3. The role of self-efficacy in SRL

In addition to metacognition, students' SRL is profoundly affected by various motivational factors. One of those factors, self-efficacy, can be described as the belief in the ability to organize and execute actions necessary to attain specific goals (Bandura, 1997). Students who believe they will be successful are more likely to be motivated and to achieve success. However, students with low self-efficacy may not only succumb to temptation, but they may let disruptive thoughts interfere with performance (Boekaerts, 1995; Bong & Skaalvik, 2003; Pintrich, 2003; Schunk, Meece, & Pintrich, 2013). Learners' self-efficacy beliefs are developed mainly through prior experiences, but can also be influenced by vicarious experiences, verbal persuasion, and physiological

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reactions (Bandura, 1986; Bong & Skaalvik, 2003; Pajares & Valiante, 2002). Research shows that students' self-efficacy beliefs influence such actions as choice of tasks, persistence, effort, and achievement (Schunk & Zimmerman, 2008).

3. Current study

Although many studies have focused on improving isolated components of SRL, relatively few have considered how each of these variables distinguishes between high and low achieving students in a classroom context over the duration of a course. The current study compared the self-regulation of high and low achieving students in an undergraduate educational psychology course using. A variety of measurements were selected to represent cognitive, metacognitive, and motivational facets of SRL models. A repeated measures design embedded within the semester was used upon recommendations by prior research in SRL (Sitzmann & Ely, 2011; Vancouver & Kendall, 2006). Metacognition and self-regulation were taught as concepts in the course and further developed using weekly reflection sheets to encourage student SRL. Students were asked to set goals at the beginning of the course and to assess the level of obtainment of their goals after each of the three examinations during the semester. A number of self-report inventories assessing strategy use, metacognition, and motivation were also administered throughout the semester. Additionally, metacognitive monitoring judgments were recorded at the item level for each exam.

Specifically, we addressed two research questions: *Do self-regulation variables differentiate between high and low achieving students*? We hypothesized that high achieving students would be more accurate in their metacognitive monitoring (Bol & Hacker, 2001; Zimmerman & Moylan, 2009), report higher levels of metacognitive awareness (Sperling, Richmond, Ramsay, & Klapp, 2012), feel more efficacious (Komarraju & Nadler, 2013; Zuffiano et al., 2013), and be more sophisticated in their strategy use (Proctor et al., 2006). The second question asked was, *How do high and low achieving students set goals, monitor progress towards goals, and adjust strategies in a course*? This research question helped to expand on the quantitative results by using qualitative data to further understand high and low achieving students. Due to the exploratory nature of this longitudinal study, one objective was to provide a description and comparison of high and low achieving students in relation to important SRL variables using both quantitative and qualitative data. This functions to assist in determining which measures could be used to identify students needing assistance early in the course, and also to assess which areas of self-regulation could be improved upon to help these students succeed.

4. Method

4.1. Participants

Participants in this study were undergraduates enrolled in two different sections of educational psychology at two different southeastern universities. The sections ($N_1 = 25$ & $N_2 = 35$) were matched for course content and sequencing of content. Moreover, all assessments and test items were identical for the two groups. Students were introduced to the study in the first week of class and all students volunteered to participate by completing the informed consent form. A sub-sample of participants ($N = 41$) were selected for this study by identifying high and low performing students using final exam scores. Participants ranged in age from 18 to 43 with a mean age of 23.24. A cross-tab of race and gender is provided in Table A.1.

4.2. Materials

4.2.1. Educational psychology pretest

At the start of the course, participants completed an educational psychology pretest to assess background knowledge in the course. The test included 25 multiple-choice items covering a range of content that was to be covered during the course ($\alpha = .28$). Internal reliability was very low likely because students had no exposure to content at that point and entered the course with little background knowledge.

4.2.2. Raven's advanced progressive matrices

Students also completed an abbreviated version of the Raven's Advanced Progressive Matrices Test (Raven, 1962) to roughly estimate nonverbal intelligence (Arthur & Day, 1994). The shortened form consists of 12 items from the original assessment ($\alpha = .69$).

4.2.3. Educational psychology content tests

In class assessments consisted of three quizzes (20 four-option multiple questions each) and a final exam (40 four-option multiple choice questions), which were identical for both sections of the course (Quiz 1 $\alpha = .65$; Quiz 2 $\alpha = .43$, Quiz 3 $\alpha = .69$, Final $\alpha = .80$). Each of the three quizzes covered unique content, and the final exam was a comprehensive measure of the course content. The questions on these four assessments were a mix of knowledge-level and application questions that ranged in level of difficulty. For the purpose of their final course grade students were allowed to drop their lowest quiz score. Quiz 2's low internal reliability was likely due to the assessment covering several distinct topics.

4.2.4. Metacognitive monitoring accuracy

Students were asked to make retrospective item level confidence judgments during the educational psychology pretest, Raven's Test, all three course quizzes, and the final exam. After answering each question, students were asked to rate their confidence level (0% to 100%) that they were correct. These individual confidence judgments were then used to calculate an overall calibration score of absolute accuracy that functioned as a measure of metacognitive monitoring precision for each assessment (Nietfeld, Cao, et al., 2006). Calibration represents the degree to which a student's perception of their performance matches with their actual performance, with lower calibration scores indicating more accurate judgments. For instance, if a student provided a confidence judgment of 79 (.79) and correctly answered the item their accuracy score would be −.21 Monitoring scores were calculated for each item and then absolute values were totaled across all items to arrive at a single index for each assessment.

We chose to calculate accuracy using Schraw's (2009) absolute accuracy calculation because we were interested in absolute change in judgments and not relative accuracy. As displayed by Nietfeld, Enders and Schraw (2006), this calculation produces more reliable accuracy estimates on short (<50 items) assessments. Due to an error in formatting, the judgment scale was missing from question twenty on the second quiz given to one section of the course. The average calibration for the first nineteen questions across participants was used to replace this missing data.

4.2.5. Metacognitive awareness

The Metacognitive Awareness Inventory (MAI) was administered immediately before the final exam during the last week of class. The MAI is a self-report measure used to assess college students' perceived metacognitive knowledge and skills (Schraw & Dennison, 1994). The MAI is comprised of 52 five-point Likert-scale items. The scale is divided into two sub-scales measuring knowledge of cognition ($\alpha = .76$) and regulation of cognitive skills ($\alpha = .90$).

4.2.6. Self-efficacy

An Educational Psychology Self-Efficacy Inventory (Nietfeld, Cao et al., 2006; Nietfeld, Enders et al., 2006) was administered in the first and last classes of the semester. This inventory consists of eight items answered on a five-point Likert scale (both the pre- and post $\alpha = .95$). The *Self-Efficacy for Self Regulated Learning Scale* (Bandura, 2001) was administered during the beginning and end of

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the course. The inventory consists of 11 items answered on a seven-point Likert scale ($\alpha = .77$ and .88 for the pre- and post administrations respectively).

4.2.7. Cognitive strategy importance ratings

Students were asked to rate the importance of twelve Learning Strategies with regard to studying the course material on a scale from 1 (Not Important at All) to 6 (Very Important) at the beginning of the course ($\alpha = .61$). After each quiz students again rated the importance of the strategies (Quiz 1 $\alpha = .72$; Quiz 2 $\alpha = .79$; Quiz 3 $\alpha = .76$). The strategy list consisted of low level learning strategies (repeating words, attending class, reading textbook), high-level learning strategies (elaboration and connections, finding themes or main ideas, applying learning), and help seeking strategies (asking the professor or other students for help).

4.2.8. Goal setting inventory

Qualitative data were collected through participants written responses to the researchers' questions. Students were asked to set learning and performance goals for course assessments, monitor their progress, and evaluate their results. The initial questions prompted students to set goals for the overall course, quizzes, final exam, class project, and focus group participation, all components of the course grade. Students set an overall goal for learning and listed attributions for reaching or not reaching their goals. Participants described their study strategies for the exam, strategies for remembering information in the course, and time allotted to preparing for the tests. Additionally, following each quiz students reassessed their learning and performance goals, and were asked if they would change goals or strategies for the next assessment.

4.3. Procedure

4.3.1. Data collection

Data were collected during class meetings once a week for 16 weeks. During the first class meeting participants completed the pre-assessments and set course goals for the semester. Each week (except during weeks with quizzes or the final exam) participants also completed a weekly monitoring exercise during which they answered five multiple-choice questions and made confidence judgments for each question. After each quiz participants reflected on their progress towards their learning goals and any changes they would make to their goals and test preparation. During the last class meeting participants completed the final exam and the post assessments for the study.

4.3.2. Analysis plan

In order to examine differences in self-regulation variables between high and low achieving students, the sample was first divided into tertiles based on participants' final exam performance. After confirming that the top and bottom tertiles' performance was significantly different, the two groups were compared on measures of self-regulation. In order to identify differences between high and low achieving students, variables measuring similar constructs were grouped together and several MANOVAs were conducted. Univariate tests were examined for all significant MANOVAs to identify which variables differed between high and low achieving students. In all instances, Bonferroni corrections were applied to all univariate results. Finally, a content analysis and frequency count was conducted on high and low performing students' individual goals and strategies to further examine differences between the groups.

5. Results

5.1. Creating comparison groups

Descriptive statistics were used to describe the sample population and confirm normal distribution for the measurements that were administered. Comparison groups were created to identify differences in self-regulation variables between high and low performing students. The final exam was used to divide the participants into thirds because it was a comprehensive test covering content from the entire semester. The top and bottom tertiles were selected for comparisons to create a clear distinction between the groups and increase the chances of finding meaningful differences. The top third ($N = 20$) had a final exam score range of 35–40 (100%–87.5%) ($M = 37.10$, $SD = 1.55$). The bottom third ($N = 21$) had a final exam score range of 20–29 (50%–72.5%) ($M = 25.86$, $SD = 2.61$). T-test statistics showed the mean scores for these two groups to be significantly different, $t(39) = 16.64$, $p < .001$, Cohen's $d = 5.24$. The top third (high achieving group) and bottom third (low achieving group) were then compared using both quantitative and qualitative data.

5.1.1. Establishing group equivalence at baseline

Participants completed a series of assessments at the start of the course to determine group equivalence. There were no differences between the high and low achieving groups at the start of the course on the Ravens, educational psychology pre-test, metacognitive monitoring accuracy for the Ravens or pretest, self-efficacy, or high-level cognitive strategies and help-seeking strategies. There were significant differences between the groups' ratings of low-level cognitive strategies and self-reported GPA, which are discussed in more detail below.

5.2. Do self-regulation variables differentiate high and low achieving students?

5.2.1. Achievement

To determine differences in prior achievement (self-reported GPA) and nonverbal ability (Ravens) between high and low achieving students, ANOVAs were conducted. These measures were analyzed separately from the content assessments because they represent knowledge and ability outside of the content area. Results showed the high achieving group had significantly higher GPAs than the low achieving group (Cohen's $d = 1.11$). There were no significant differences between the groups on their Ravens scores (Table A.2).

A MANOVA was used to compare the high and low achieving groups on the content assessments (pretest and three quizzes). There was a significant main effect for the groups, (Wilks's $\lambda = .50$, $F[4, 36] = 8.84$, $p < .001$, partial $\eta^2 = .50$). Univariate tests showed the high achieving group scored significantly higher on Quiz 1 ($d = 1.88$) and Quiz 3 ($d = .67$). There were no significant differences between the two groups on the pretest or Quiz 2 (Table A.3).

5.2.2. Metacognitive monitoring accuracy

MANOVA was used to compare monitoring accuracy between the high and low achieving groups on the Ravens, pretest, quizzes, and final exam. There was a significant main effect for the groups, (Wilks's $\lambda = .33$, $F[6, 33] = 11.01$ $p < .001$, partial $\eta^2 = .67$). The univariate ANOVAs revealed significant differences between the high and low achieving groups' monitoring accuracy on Quiz 1 ($d = 1.22$), Quiz 3 ($d = .84$), and the final exam ($d = 2.18$). The difference in monitoring accuracy on Quiz 2 ($d = .63$) was also approaching significance ($p = .059$). In all cases the high achieving group was more accurate in their monitoring (See Table A.4).

5.2.3. Self-efficacy

Participants completed measures for self-efficacy for educational psychology and SRL. A repeated measures ANOVA was used to examine the differences between the high and low achieving groups' self-efficacy for educational psychology and self-efficacy for SRL (see Table A.5). The within-subjects factor was time (pretest, posttest) and the between subjects factor was group (high, low). There was a significant interaction between time and group on the self-efficacy for educational psychology assessment (Wilks's $\lambda = .88$, $F[1, 39] = 5.27$ $p < .05$, partial

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$\eta^2 = .12$), but no differences were found on the self-efficacy for SRL measure (Wilks's $\lambda = .97$, $F[1, 39] = 1.28$ $p = .27$, partial $\eta^2 = .03$). The interaction between self-efficacy for educational psychology and time was decomposed and showed that there were no differences between the groups at the pretest, but there was a significant difference at the posttest. The high achieving group scored significantly higher than the low achieving group ($d = 0.88$).

5.2.4. MAI

The total score and individual construct scores for the Metacognitive Awareness Inventory were compared between the high and low achieving groups using a MANOA (Table A.6). The main effect for group was not significant, but was approaching significance (Wilks's $\lambda = .78$, $F[4, 36] = 2.49$ $p = .06$, partial $\eta^2 = .22$). A review of the univariate results showed the only significant difference occurred in the metacognitive conditional knowledge construct ($d = .76$). The low achieving group reported significantly higher levels of metacognitive conditional knowledge, a finding that was unexpected based upon other available data. Further analysis showed no significant correlational relationship between achievement on the final exam and metacognitive conditional knowledge, bringing the predictive validity of this measure for achievement into question.

5.2.5. Cognitive strategies

MANOVAs were used to examine differences in low-level strategy use, high-level strategy use, and help seeking strategies between the groups (See Table A.7). There was a significant main effect for group (Wilks's $\lambda = .70$, $F[4, 36] = 3.86$ $p < .05$, partial $\eta^2 = .30$) for low-level strategies. Univariate results show a significant difference between the high and low achieving groups when rating the importance of the low level learning strategies at the start of the course ($d = .65$), after the first quiz ($d = 1.00$), and after the third quiz ($d = .99$). In all three of these instances, low achieving students rated the low level strategies as more important than the high achieving students. There was no significant difference between the two groups on the low level learning strategy ratings after the second quiz. There was no significant effect for group on ratings of high-level strategies (Wilks's $\lambda = .89$, $F[4, 36] = 1.10$ $p = .37$, partial $\eta^2 = .11$) or help-seeking strategies (Wilks's $\lambda = .92$, $F[4, 36] = .77$ $p = .55$, partial $\eta^2 = .08$).

5.3. How do high and low achieving students set goals, monitor progress towards goals and adjust strategies in a course?

Data from the Goal Setting Inventories were transferred to a spreadsheet for analysis. The qualitative data were not rich enough to justify an in depth qualitative analysis because participants wrote their responses to questions prompts rather than being interviewed. Instead, a content analysis and frequency count were performed on the data to better understand differences between the high and low achieving groups.

The content analysis began with a complete reading of participant responses for each question. Common responses were noted within the high and low achieving groups in relation to goal setting, goal orientation, study strategies, and goal adjustments, and were used to create categories within the participants' responses to each question. Two raters conducted frequency counts using common categories for each question on half of the high achieving group and half of the low achieving group and frequencies were compared for consistency. The inter-rater reliability was 92%. Discrepancies were discussed and final determinations were made. A single rater coded the remaining data. Enumerated data were compared between the high and low achieving groups to identify differences. Pertinent quotes and responses were used to describe the participants in these groups and their study habits, reported strategy use, and responses to assessment feedback.

At the beginning of the course, participants were asked to set goals for their quizzes and final exam. Participants in both the low (43%) and high (55%) achieving group wanted to earn an "A" on the class quizzes. Similarly, the low (48%) and high (50%) achieving group also set the goal of earning an "A" on the final exam. Participants were also asked to set learning outcome goals for the course as a whole at the beginning of the semester. While some participants listed vague goals (ex. learn a lot about educational psychology, apply information to life), 52% of the low achieving group and 65% of the high achieving group set specific goals (ex. learn effective study techniques, learn strategies for assessing the progress of my future students) for using the course content in their future professions or lives (Table A.8).

Students were also asked to list the strategies they planned on using to prepare for exams, which were reviewed to identify the preferred learning strategies. Participants in both the low and high achieving groups mentioned making notecards or flashcards for studying. Only participants in the low achieving group, however, listed repetition as a strategy for studying. The strategies described by participants in the two groups represented very different approaches to learning. For example, one participant in the low achieving group wrote that in preparation for exams, they liked to "make notecards, then review notecards 1000 times or until I know it." A participant from the high achieving group said they liked to "make study sheets on important concepts, review important concepts on sheets, 'testing self'."

Participants in the high and low achieving groups also reported different approaches to time spent studying. When asked what strategies they would use to prepare for exams, a member of the low achieving group realized that they needed to prepare for the exam ahead of time and said, "study the day before the exam but never on the day of the exam." A member of the high achieving group, however, noted that they needed to "start reviewing several days in advance." Another high achieving student reported that they "usually read my notes everyday after class, as time goes on I also read the previous lecture notes along with the newest notes that way I don't cram for exams." This shows a difference in time spent preparing for tests between the two groups. High achievers began preparing early for these tests, using spaced (Son & Simon, 2012) rather than massed practice.

After each quiz participants reviewed their learning and performance goals and noted if they would change these goals. A similar number of participants in the high and low achieving groups noted changing their goals. Participants were also asked if they would adjust their strategies for studying for the next assessment. In the low achieving group, 86% of participants planned to change study strategies after the first quiz, but only 40% of participants in the high achieving group wanted to change strategies. Similarly, after the second quiz 76% of participants in the low achieving group and 40% in the high achieving group wanted to make changes to their study strategies. There was no difference in the number of participants who wanted to change strategies after the third quiz (high achieving = 55%; low achieving = 52%). Most noted that the final exam would require more time spent studying than had previously been spent.

Participant responses also indicated varying levels of metacognitive awareness when discussing their strategy changes. After the third quiz, one participant in the low achieving group responded that, "I studied really, really, really hard for quizzes 2 and 3 and still came up with a bad grade, however [on] quiz 1 I studied less for [it] and did better, so I don't know what to do". Similarly another member of the low achieving group also stated that, "the test that I barely studied for gave me my highest grade." These remarks indicate a lack of metacognitive awareness and ability to discriminate between effective and ineffective study approaches. On the other hand, a participant from the high achieving group responded that they would make "some" changes to strategies because on the "last test I thought through more examples and did better on [the] types of questions I missed this time." This individual's responses indicate a high level of metacognitive awareness because they knew which strategy had worked previously and needed to be used again. Another high achieving student reported that, "I will spend more time studying concepts rather than rereading

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notes," indicating the student recognized a weak area in their learning and had a plan to address this issue.

6. Discussion

The purpose of this study was to identify important differences in SRL between high- and low-performing college students in order to provide direction for remediation in a classroom context. We highlight three major findings from our data: 1) important differences existed between the high and low achieving students in this study in relation to metacognitive monitoring, reported use of low-level study strategies, and self-efficacy; 2) early course performance rather than baseline measures of SRL components and prior knowledge was indicative of summative course achievement; and 3) self-report measures of SRL did not align with measures of achievement, monitoring judgments, or interview data indicating that these measures should be used with caution when examining SRL in college classroom contexts. A major strength of these results is the use of ecologically valid instruments and measures in the context of one course.

Differences between students who would eventually score high versus low on the final exam in this study emerged quickly as significant differences in performance and metacognitive monitoring accuracy were evident after the first quiz and again on the third quiz. Moreover, low performing students also rated low-level cognitive strategies as being more important at the start of the course, and also following the first and third quizzes. Low-achieving students' reliance on poor strategies is even more striking considering that SRL concepts and skills were a focus of the course. The second quiz did not follow this pattern, as there were no differences between the groups in performance or in their rating of cognitive strategies. However, despite the two groups scoring similarly on the second quiz, the high achieving students were still more calibrated in their learning judgments and thus showed consistent monitoring accuracy advantages across all measures of performance, replicating findings in prior research (Hacker, Bol, Horgan, & Rakow, 2000). High-achieving students also showed a clear advantage in self-efficacy at the end of the semester indicating important changes relative to their peers over the course of the semester. This finding aligns with previous classroom research that shows the importance of changes in monitoring and self-efficacy on summative course measures (Cao & Nietfeld, 2007b; Nietfeld, Cao et al., 2006; Nietfeld, Enders et al., 2006). Thus, even in a situation where high and low achieving students performed similarly, low achieving students still displayed a lack of control of their learning, suggesting that achievement relies on underlying characteristics of individual students (metacognitive abilities, motivation, interest) and their approaches to learning. Interestingly, the differences in self-efficacy between groups were the result of a significant decrease on the part of the low-achieving students. This finding may reflect a certain level of overconfidence on the part of low-achieving group at the beginning of the course.

Qualitative data exemplified differences between the high and low achieving groups. High achieving students set more specific goals for the course, made strategy changes that were specific to their performance, selected more effective study strategies such as spaced studying (Son & Simon, 2012), and did not rely on repetition and flashcards to the extent reported by the low achieving group. These findings align with previous research showing that high-achieving students tend to show more adaptive SRL patterns such as effective goal setting, goal monitoring, and approaches to studying than low-achieving students (Pintrich & De Groot, 1990; Zimmerman, 1990, 2008). Overall, the student goal setting and monitoring sheets used in class supported the findings that high achieving students are more strategic and accurate in monitoring their learning. Given the lack of significant differences for high-level cognitive study strategies ratings used in this study, it might be useful to employ a more open-ended response to determine the strategies used by students. When students were provided with a list of study strategies to select from, low achieving students rated all strategies as useful, in spite of the course's focus on SRL strategies. They did not differentiate between strategies and do not appear to accurately report their habits. However, when asked to list what strategies were used to prepare for tests, low achieving students listed more low-level strategies and high achieving students listed more high-level strategies. Other studies have also identified a difference in high and low achieving students' knowledge of appropriate strategies and their application of these strategies (Cao & Nietfeld, 2007a; Proctor et al., 2006). If students are asked to list and discuss how they study for a class, they may be more likely to accurately report the strategies they use and less likely to select the socially desirable answers from a list.

Findings in this study also highlighted the difficulty in identifying those students who will perform at high levels and exhibit strong SRL skills. While low-achieving students did report a greater initial reliance on low-level learning strategies, there were no differences between the high and low achieving groups on measures of prior knowledge, non-verbal reasoning, metacognitive monitoring, or self-efficacy. Differences between groups emerged after students had spent time in the class and were exposed to the content of the course. This suggests that context is important for student achievement and SRL (Wolters & Pintrich, 2001) and remediation decisions should be considered early on, after exposure to the content, when information is available from initial assessments. These findings also caution the overemphasis of baseline measures in their ability to predict self-regulation and performance. Frequent formative assessments are recommended over baseline measures to identify struggling learners and provide assistance.

Significant differences between the high and low-achieving groups in GPA were found, indicating a consistency in performance across courses. While prior achievement may indicate differences in students' self-regulation, contextual factors may influence their learning as well. For instance, when students' performance in actual classrooms are measured a number of variables such as task value, interest, prior knowledge, goals, and many others may affect performance in a unique way. Students likely respond in a somewhat different fashion in each course due to variations in the variables listed above (and others).

Self-report measures in this study did not readily differentiate between the high and low achieving groups. The second measure of self-efficacy for educational psychology did distinguish between the two groups, but was administered too late in the course to be useful in identifying students for remediation. Self-efficacy for SRL did not show differences between the high and low achieving students when administered at the beginning nor end of the course. Our results for the self-efficacy for SRL scale appear to be generally in opposition to those found by Zimmerman (1995). Results from the MAI indicated that low achieving students possessed higher levels of metacognitive conditional knowledge, a characteristic thought to belong to high-achieving students. Interestingly, however, students in the low achieving group continued to provide consistent ratings for the importance of low-level repetition-based strategies, whereas students in the high-achieving group indicated decreased importance of such strategies as the semester progressed. Results from self-report measures used in this study suggest that participants are unable or unwilling to accurately respond to these measures. Additionally, the self-reports may not be fully addressing the constructs they were intended to measure. The ability of self-report measures to capture accurate information has been questioned in previous studies (Winne & Jamieson-Noel, 2002) and their validity is highly dependent upon the purpose and context of their use.

6.1. Summary

Significant differences exist in the self-regulation of high and low achieving students and these differences can be targeted in the re-design of instruction. While it is common to use pretests and other indicators of achievement early in a course, the information

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provided by these instruments was not related to the summative measure of achievement in this study. It appears that contextual factors may influence student achievement and therefore instructors should allow students to adjust to the class before attempting to identify students for intervention. Weekly formative assessments would also be useful in identifying students for remediation. Additionally, working to improve metacognitive monitoring and study strategy selection may prove fruitful endeavors in improving self-regulation and learning. Providing students with opportunities to practice low and high-level strategies side-by-side can also help show the benefits of the high-level strategies.

6.2. Limitations and future research

Future research should focus on existing self-report measures to determine their utility in research and applied settings. While the construction of some instruments may be problematic, the timing of the instrument administration may also impact validity. The only self-report measure that showed a difference between the high and low achieving students was the second administration of the self-efficacy for educational psychology measure. This self-report instrument appears to measure something of value, but only after students have experience in the course. Looking at the timing of administration for this measure and others may be a valuable endeavor.

Additionally, researchers should seek ways to measure motivation, metacognition, and strategy use that do not require self-reports. Observational measures, for instance, can capture students' actual strategies and decisions unlike self-reports which are subject to social desirability and reporting bias. The confidence judgments taken in the current study are an example of observational measures that are easy to implement. Further, measures taken during learning, without interfering in ongoing processes, can more accurately capture the strategies being used. Computer programs that monitor and track learners' applied strategies, time spent studying, and materials referenced are another method for observing SRL behaviors during learning. The development of these types of learning tools can improve our understanding of SRL and allow us to provide learners with timely assistance.

Given our interest in direct comparisons between groups of high and low-performing students, we were limited methodologically to comparisons made by numerous univariate *F*-tests. The limitation here is the increased chance of making a Type I error and concluding that a comparison is significant when the differences are actually due to measurement error or chance. However, we took this approach using Bonferroni corrections and maintaining consistent *p* values when considering a threshold for significance. To compensate for this we recognize the exploratory nature of the comparisons in the current study and have also provided effect size estimates in order to reveal the actual magnitude of differences for comparisons that revealed significant differences between groups.

The results of this study are also limited by the concentration in one content area. Future studies can further this research by studying the same participants across multiple content areas and also by examining learners of various ages. Adding observational measures and open-ended response questions could also lead to improved results when trying to understand the differences between high and low achievers.

Appendix A

Table A.1
Cross-tab of race and gender for sample ($N = 41$).

	White	Black	Hispanic	Asian American	Total
Male	4	1	0	1	6
Female	28	6	1	0	35
Total	32	7	1	1	

Table A.2
Univariate results comparing non-classroom achievement ($N = 41$).

	High achieving		Low achieving		*F*	(*d*)
	M	(SD)	M	(SD)		
Ravens score	8.80	(2.24)	7.52	(2.79)	2.60	
GPA	3.47	(.42)	3.07	(.30)	12.35**	(1.11)

** $p < .01$.

Table A.3
Univariate results from MANOVA comparing classroom assessments ($N = 41$).

	High achieving		Low achieving		*F*	(*d*)
	M	(SD)	M	(SD)		
Pretest score	14.15	(2.23)	13.00	(3.03)	1.90	
Quiz 1 score	18.15	(1.5)	14.29	(2.49)	35.76***	(1.88)
Quiz 2 score	16.50	(2.84)	15.19	(1.86)	3.08	
Quiz 3 score	16.20	(4.95)	13.62	(2.20)	4.25*	(.67)

* $p < .05$.
*** $p < .001$.

Table A.4
Univariate results from MANOVA comparing metacognitive monitoring accuracy ($N = 41$).

	High achieving		Low achieving		*F*	(*d*)
	M	(SD)	M	(SD)		
Pretest calibration	11.28	(1.65)	11.09	(1.50)	0.15	
Ravens calibration	0.19	(.21)	0.16	(.21)	0.06	
Quiz 1 calibration	4.67	(1.99)	7.28	(2.27)	15.24***	(1.22)
Quiz 2 calibration	5.44	(2.31)	6.63	(1.36)	4.08*	(.63)
Quiz 3 calibration	5.94	(2.11)	7.58	(1.82)	7.03*	(.84)
Final exam calibration	7.17	(4.01)	14.93	(3.05)	48.88***	(2.18)

* $p < .05$.
*** $p < .001$.

Table A.5
2×2 Repeated-measures ANOVA results for self-efficacy ($N = 41$).

	High achieving		Low achieving		*F*	(*d*)
	M	(SD)	M	(SD)		
Pre-self-efficacy for Ed psych	32.90	(3.35)	31.38	(4.23)	1.62	
Post-self-efficacy for Ed psych	31.72	(5.98)	26.67	(5.46)	7.99**	(.88)
Pre-self-efficacy for SRL	56.00	(7.29)	59.24	(7.27)	2.03	
Post-self-efficacy for SRL	56.25	(9.81)	56.57	(12.01)	.01	

** $p < .01$.

Table A.6
Univariate results for MANOVA comparing MAI total score and sub-scales ($N = 41$).

	High achieving		Low achieving		*F*	(*d*)
	M	(SD)	M	(SD)		
MAI-total score	197.10	(18.34)	202.95	(21.54)	.88	
MAI-declarative knowledge	32.80	(2.78)	32.62	(3.25)	.04	
MAI-procedural knowledge	16.05	(1.82)	15.86	(2.57)	.08	
MAI-conditional knowledge	19.35	(1.82)	20.86	(2.13)	5.95*	(.76)

* $p < .05$.

Table A.7
Univariate results for MANOVAs comparing strategy ratings ($N = 41$).

	High achieving		Low achieving		*F*	(*d*)
	M	(SD)	M	(SD)		
Pre-low strategies	14.65	(1.57)	15.76	(1.84)	4.32*	(.65)
Post Quiz 1-low strategies	12.90	(2.40)	15.19	(2.16)	10.32**	(1.00)
Post Quiz 2-low strategies	12.80	(2.19)	14.19	(2.96)	2.90	
Post Quiz 3-low strategies	12.30	(1.78)	14.19	(2.02)	10.10**	(.99)
Pre-high strategies	14.65	(1.57)	15.76	(1.84)	2.88	
Post Quiz 1-high strategies	14.10	(2.95)	13.67	(2.65)	.25	
Post Quiz 2-high strategies	14.15	(2.41)	14.76	(2.36)	.67	

(continued on next page)

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Table A.7 (*continued*)

	High achieving		Low achieving		*F*	(*d*)
	M	(SD)	M	(SD)		
Post Quiz 3-high strategies	14.10	(2.88)	13.81	(2.56)	.12	
Pre-help strategies	9.20	(1.79)	9.48	(1.44)	.30	
Post Quiz 1-help strategies	7.75	(2.67)	8.48	(2.14)	.93	
Post Quiz 2-help strategies	8.00	(2.85)	8.71	(2.12)	.83	
Post Quiz 3-help strategies	7.90	(2.38)	9.10	(1.89)	3.18	

* $p < .05$.
** $p < .01$.

Table A.8
Coding results for individual learning goal and strategy questions.

Question themes	Tertiles	
	Bottom ($N = 21$)	Top ($N = 20$)
Beginning of semester survey		
Goal setting: "A" on class quizzes at the beginning of the semester	9	11
Goal setting: "A" on final exam at the beginning of the semester	10	10
Learning goal: specific and future oriented	11	13
Strategies to learn information: notecards/flashcards	10	6
Strategies to learn information: specific mention of repetition	6	0
Post Quiz 1		
Changing learning goals	10	6
Changing performance goals	7	5
Changing strategies	18	8
Post Quiz 2		
Changing learning goals	6	5
Changing performance goals	9	9
Changing strategies	16	8
Post Quiz 3		
Changing learning goals	4	5
Changing performance goals	4	6
Changing strategies	11	11

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