Metacognition Learning (2015) 10:15–42
DOI 10.1007/s11409-014-9129-8

Integrating the regulation of affect, behavior, and cognition into self-regulated learning paradigms among secondary and post-secondary students

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Received: 25 November 2013 / Accepted: 28 November 2014 /
Published online: 8 February 2015

Abstract An integrative framework for investigating self-regulated learning situated in students' favorite and least favorite courses was empirically tested in a sample of 178 high school and 280 college students. Building on cognitive, clinical, social, and educational conceptions of self-regulation, the current paper integrated affective (e.g., reappraisal, suppression), behavioral (e.g., environmental, planning), and cognitive (e.g., cognitive focusing, metacognition) forms of regulation with self-regulated learning strategies (deep and surface processing, organization, engagement) to predict achievement. Overall, self-regulation was employed more frequently in favorite courses and by college students. Path models examined the associations of affective, behavioral, and cognitive regulation with learning strategies and achievement. These analyses suggested that affective, behavioral, and cognitive regulation were related to learning strategies, but the links to achievement were less robust. Moreover, there were significant indirect paths from behavioral and cognitive regulation to achievement through learning strategies, although some of these indirect paths were counter to expectations.

Keywords Self-regulation · Cognition · Emotion · Behavior · Learning · Self-regulated learning · Development · Liking

Self-regulation, or the process of monitoring one's current state and subsequently adjusting towards optimal levels, is essential to our existence more broadly as well as our learning (Baumeister and Vohs 2004; Boekaerts et al. 2000; Hoyle 2010; Pintrich 2000; Winne and Nesbit 2010; Zimmerman 1989, 2006). Broadly speaking, one can consider the regulation of emotions, cognitions, and behaviors. These forms of regulation are interlinked and critical to consider with respect to education, as all three forms influence learning processes (D'Mello and Graesser 2014; Jacobs and Gross 2014). The current study sought to test an integrative self-regulated learning framework (see Fig. 1), whereby the regulation of emotions, behaviors, and

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cognitions combine with highly studied learning strategies (e.g., rehearsal, elaboration) to shape achievement. Specifically, we built on the iSRL model (Ben-Eliyahu and Bernacki 2015) to propose that the regulation of affect, behavior, and cognitions sets the stage for successfully employing learning strategies and, ultimately, enhances academic achievement. For instance, students who are not optimally emotionally aroused, lack planning capabilities, or struggle to focus will be unsuccessful in applying self-regulated learning strategies such as elaboration, which will in turn hinder academic achievement. In contrast, students who are able to regulate basic emotions, behaviors, and cognitions will be more adept at applying learning-specific strategies, which will lead to higher levels of achievement. We applied this integrative framework to investigate self-regulated learning across two contexts (favorite and least favorite courses) for college and high school students. By considering two types of courses and different age groups, we also sought to understand whether the general integrative framework held across contexts and to explore potential differences in the regulatory demands and functions based on age and context.

An integrated framework for self-regulation

As we discuss in greater detail in the following section, our framework merges the relatively independent literatures on affective, behavioral, and cognitive regulation originating in clinical, cognitive, and social psychology with self-regulated learning from educational psychology. With respect to regulatory processes, we propose that three basic forms of self-regulation (emotional, behavioral, and cognitive) are critical and can be defined as the processes that influence emotions, behaviors, and cognitions, respectively. That is, emotion regulation (or behavioral or cognitive) considers the emotional outcome (or behavioral or cognitive, respectively) that is experienced through regulation. We conceptualize emotion regulation both in terms of reframing a situation in a positive light, known as *reappraisal*, as well as *suppressing* maladaptive emotions (Gross 1998; Gross and John 2003). To conceptualize behavioral regulation, we build on work suggesting that adjusting one's *environment* (Corno and Mandinach 1983; Zimmerman 1989, 2006) and *planning* when to do certain tasks (Pintrich 2000; Xu 2008) are crucial for learning. We draw from work on *attention* (Posner et al. 1980) and *metacognition* (Flavell 1979; Pintrich 2000) to consider cognitive regulation. We propose that these three forms of self-regulation are in turn related to self-regulated learning strategies (deep processing, engagement, and organization) and behavioral-cognitive engagement, which ultimately determine achievement (see Fig. 1). Furthermore, we hypothesize that these relations will be slightly different based on age (high school and college students) and context (favorite versus least favorite courses).

The current work builds upon previous models of self-regulation in learning in several ways. First, similar to prior models (Boekaerts 1999; Greene and Azevedo 2009; Pintrich 2000; Vrugt and Oort 2008; Zimmerman 2002), we distinguish between broader and more

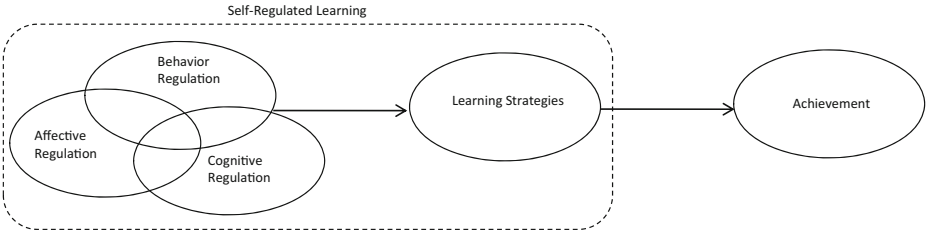

Fig. 1 An integrated framework for investigating self-regulated learning (iSRL)

specific types of self-regulation. However, slightly differently from previous work, we consider the regulation of affect, behaviors, and cognitions as rudimentary to learning. Extending Pintrich's (2000) description of metacognition influencing learning strategy use, we propose that control and regulation of emotions and behaviors also influence learning strategy use and engagement. In this sense, parallel to metacognition would be metaaffect and metabehavior, and parallel to learning strategy use would be the experience of emotions, and certain behaviors, respectively. In applying our framework, we draw on the iSRL model presented in the introduction to this special issue. Our goal is to begin to examine what these "meta" or broad level cognitive, affective, and behavioral processes look like, and how they differ and relate to strategies and processes that influence learning directly. That is, we differentiate between strategies such as rehearsal and deep processing that result in acquisition versus activation, planning, monitoring, controlling, and reflection of these processes.

Our approach is also different from prior work that focused on levels of metacognitive and cognitive learning strategies (e.g., Greene and Azevedo 2009). In particular, Greene and Azevedo described 35 microprocesses categorized into five macroprocesses. Their approach allows investigation of how microprocesses combine differently within a macroprocess. While this approach is important and useful, in our model, we propose that regulatory processes such as metacognition regulate cognitions that are specific to learning (Vrugt and Oort 2008), enabling acquisition to occur. In this sense, regulation of affect, behavior, and cognition precedes learning strategies (see Fig. 1).

The second way in which our integrated framework aligns with prior work is in considering multiple aspects (affect, behaviors, and cognitions) of the individual that operate in conjunction (e.g., Boekaerts 1999; Efklides 2011; Li 2011; Pintrich 2000; Pomerantz and Shim 2008; Snow et al. 1996). Other models have theorized about emotions, behaviors, and cognitions as part of self-regulated learning, either as separate components or grouped with motivation (e.g., Pintrich 2000) and thus our framework builds and extends on this prior work. Third, we believe the context (interacting with the person) influences the ways and intensities in which regulatory capacities are employed (Pintrich 2004). We therefore contextualize our model within particular classroom contexts – favorite and least favorite courses. We also consider how development and educational settings shape regulation by including both high school and college samples.

Affective, behavioral, and cognitive regulated learning

In the current study, we draw from a broad literature on self-regulation to consider affective (reappraisal and suppression), behavioral (environmental and planning), and cognitive (metacognition and focus) regulation. Below, we provide more background related to these regulatory processes.

Affective regulation

Research in clinical psychology highlights the importance of affective regulation for well-being and learning (Gross 1998, 2008; Nolen-Hoeksema et al. 1993). Two forms of regulation that have been highly studied within clinical psychology are *reappraisal* – reframing the situation to reduce undesired emotions; and *suppression* – not expressing one's emotions (Gross and John 2003). Although both reappraisal and suppression are perceived by the individual as successful regulation efforts, research suggests that reappraisal is more adaptive, as it relates to adaptive outcomes such as efficacy of negative mood regulation and repair and academic achievement (Gross 1998; Gross and John 2003; Gumora and Arsenio 2002).

Suppression, when measured as a trait, is related to undesirable characteristics such as lack of authenticity, rumination, lack of emotional clarity, and lower levels of positive emotions (Gross and John 2003). Thus, in general, trait-like tendencies to engage in suppression suggest that it is not a desired approach to emotion regulation and seems to contribute more to emotional instability rather than to a positive stable demeanor.

However, recent evidence suggests that emotion regulation may function somewhat differently when situated in learning settings such as favorite versus least favorite courses (Ben-Eliyahu and Linnenbrink-Garcia 2013). In contrast to prior research, Ben-Eliyahu and Linnenbrink-Garcia found that suppression of emotions was associated with the experience of positive emotions in disliked courses, thus having a more adaptive function in least favorite courses. Emotions and their regulation may be especially pertinent in disliked courses because students likely experience negative affect both prior to and during class. This stands in contrast to favorite courses in which students might experience positive emotion before and during their course, thereby making emotion regulation unnecessary. Because emotions organize and facilitate other psychological processes such as attention and problem-solving (Cole et al. 2004), emotion regulation is thought to be especially important for successful task completion in disliked courses. Additionally, prior research suggests that it is important to consider developmental differences in emotion regulation, as young adults appear to be more adept at using emotion regulation and employ it more frequently than do adolescents (McRae et al. 2012). For example, McRae et al. (2012) reported increased brain activity associated with use of reapparaisal in adults in comparison with adolescents and children.

Behavior regulation

Behavior regulation is often included in broader conceptions of self-regulated learning and has its roots in educational psychology more so than affective and cognitive regulation. While there are many different kinds of behavior regulation, the current study focuses on behaviors that are crucial for employing complex learning strategies such as allowing for appropriate amount of time to study (i.e., planning) and creating an environment conducive to learning (i.e., environmental regulation) (Pintrich 2000; Zimmerman 1989, 2006). More specifically, *environmental regulation* refers to the ability to choose and adjust the learning environment to ensure optimal learning conditions (Corno and Mandinach 1983; Zimmerman 2000, 2006). Both the need to employ environmental regulation and the effectiveness of environmental regulation in supporting the use of learning strategies may vary based on development and varying contextual demands for high school and college students. For instance, high school students have less independence in determining where they study or particular characteristics of their study space. College students, on the other hand, should be able to employ environmental regulation as they gain more independence. Thus, we hypothesize environmental regulation to be more strongly associated with self-regulated learning strategies among college students.

While environmental regulation determines where one studies, *time planning* influences what, when, and for how long one studies (Pintrich and Garcia 1991; Xu 2008). Allotting enough time to work on an academic task, which competes with many other desired activities (e.g., sports, spending time with friends, family obligations), is crucial, especially as youth transition into the independence of young adulthood. Time planning is dependent on accurate identification of sub-tasks and how long each task will take, but also requires some flexibility, especially with new learning tasks. Therefore, monitoring and adjusting time according to actual task progress is also important. We consider time planning to be a key regulatory capacity, especially for long-term projects such as writing papers or for large amounts of learning materials. As with environmental regulation, the increased independence experienced by college students and the increased demands for effective

time management suggest that time planning may be more strongly associated with self-regulated learning strategies among college students.

Cognitive regulation

In addition to emotion and behavior regulation, an ability to focus and shift focus when drifting off facilitates the use of deep processing and elaborative thinking. It is therefore crucial to attend to a task while ignoring irrelevant stimuli (Cherry 1953; Corno 1986; Rensink et al. 1997). We considered cognitive *focus* as the ability to control and adjust attention towards the particular task/content. Focusing includes both the ability to harness attention towards the task at hand and simultaneously refrain from elaboration of irrelevant stimuli. This form of regulation is especially important, as it is highly likely that irrelevant thoughts arise during learning activities, particularly in disliked courses. Of course, some filtering of relevant and irrelevant stimuli may occur automatically and thus would not be considered a form of intentional cognitive regulation. For instance, high intense focus is characteristic of flow states (Csikszentmihalyi 1990) during which irrelevant cognitions are automatically terminated. And, processes such as selective attention and change blindness generally occur at an unconscious level yet influence task engagement (Schunk 2004; Zimmerman 2000). In the current work, however, our focus is on intentional forms of regulation.

Research on the relations between attention regulation and academic achievement points to a positive association between focusing and learning throughout the lifespan (see McClelland et al. 2010). For instance, Steinmayr et al. (2010) examined how sustained attention predicted academic achievement in German high school students. They found that levels of intelligence interacted with sustained attention such that sustained attention was only related to achievement among students who were above medium/average verbal intelligence. For students who continued to focus despite incorrect solutions, numerical intelligence predicted math achievement. This finding suggests that the ability to regulate attention and sustain focus when necessary is crucial for academic achievement. Indeed, without attending to the learned materials or to the assignment, one cannot engage or complete the assigned task.

Many cognitive processes related to learning are facilitated by knowledge about the ways that thoughts, cognitions, and knowledge function. This family of knowledge about cognitions is referred to as *metacognition* and includes goal setting, monitoring of progress, strategy use, and self-instruction (Corno 1986; Flavell 1979; Pintrich 2000; Winne and Nesbit 2010; Zimmerman 2006). Metacognitive processes include an understanding of how cognition works, an awareness that there are different cognitive processes that facilitate task engagement, and the ability to implement a variety of processes at will. For example, elaboration may not be a good strategy for learning the periodic table in chemistry, but it could be useful for remembering psychological theories, whereas rehearsal might work well for the former but not the latter. Monitoring and adjusting strategies and processes according to the desired learning outcome allows for effective learning and supports mid-task adjustments via feedback loops. In this way, a student who notices that a certain study strategy is not conducive to the task (e.g., memorizing by re-reading) can try a different strategy to facilitate the learning process (e.g., taking notes while reading). By monitoring how this new form of processing and organization influences acquisition, strategies can be readjusted as necessary. Thus the use of metacognition should influence the types of specific self-regulated learning strategies that are used.

Prior research suggests metacognition is positively related to academic achievement (e.g., Lan 1996; Ormrod 2008; Pintrich and De Groot 1990; Vrugt and Oort 2008). The present study further examines how metacognition relates to levels of processing and engagement, and ultimately achievement, situated within favorite and least favorite courses. We expect that in

least favorite courses, students need to be more planful and monitor their progress in comparison with favorite courses, in which these forms of engagement may occur without explicit regulation. Given the greater level of expertise in cognitive regulation for college students (Pintrich and Zusho 2002), it is also expected that college students will not only have higher levels of metacognition and cognitive focusing, but that there will also be stronger relations between these forms of cognitive regulation and learning.

Learning strategies

Our definition for self-regulated learning strategies draws on early work in educational psychology that described deep and surface processing of the materials, organization, and overall engagement as crucial for learning (Corno 1986; Corno and Mandinach 1983; Pintrich 2000; Vrugt and Oort 2008; Zimmerman 2002). Pioneers of research on self-regulated learning sought to elucidate how cognitive learning processes, such as cognitive engagement, can be monitored and controlled during learning episodes (Corno 1986; Corno and Mandinach 1983; Winne and Hadwin 1998). In line with this approach, study strategies were the hallmark of initial research and theory on self-regulated learning (Winne and Hadwin 1998), which focused on learning specific ideas or concepts such as addition (Winne 2011) or learning during specific tasks (e.g., exam).

We conceptualize learning strategies and engagement as leading directly to learning and knowledge acquisition (see Fig. 1). For instance, elaborating on course materials (deep processing) should have a direct connection to students' learning in that it helps students create a more elaborated network of knowledge. In contrast, the regulation of emotions, behaviors, and cognitions may be more indirectly connected to learning and achievement. Time planning, for example, may facilitate the use of effective learning strategies, as students who allocate ample time are likely to have a greater opportunity to elaborate on concepts and make deeper connections. However, time planning itself (e.g., creating a schedule for studying) does not directly facilitate learning if one does not engage in effective study strategies during that allocated study time.

Highly studied learning strategies include deep and surface processing, organization of the learning materials, and behavioral-cognitive engagement, all of which were found to be important for processing school-related learning materials by scholars over the past several decades (e.g., Li 2011; Pintrich and De Groot 1990; Winne and Hadwin 1998). *Deep processing* of the materials refers to elaboration of the content to other content domains or across learning contexts (e.g., if a student learns about water evaporation in a science class on climate change, she or he might also think about water evaporation through steam when cooking or when taking a hot bath). Through elaboration and making connections, information is deeply embedded. Deep processing can be contrasted with *surface processing*, such as rehearsal and non-elaborative learning whereby the information is maintained at the surface level. *Organizing* of the materials refers to the use of organizational techniques such as highlighting and making lists to facilitate the learning process (Pintrich and De Groot 1990).

Although generally not considered a self-regulated learning strategy, we include engagement with learning strategies for two reasons. First, our definition of *engagement* focuses on behavioral-cognitive strategies such as attending class, preparing for class, paying attention, and participating (Assor, Kaplan, and Roth 2002). Thus our definition and operationalization of engagement is comparable to learning strategies that are context-specific. Second, we posited that, like learning strategies, affective, behavioral, and cognitive regulation influence course engagement, which in turn influences learning. Thus, engagement, like learning strategies, is more proximal to learning than affective, behavioral, and cognitive regulation.

Current study

To understand how affective, behavioral, and cognitive regulation influence learning strategies, and ultimately, students' achievement, the current study drew from cognitive, social and clinical psychology to extend current self-regulated learning frameworks to include affective, behavioral, and cognitive regulatory capacities. Our study design and analyses were informed by the notion that the relations of the regulation of affect, behaviors, and cognitions to learning strategies are closely tied, such that affective, behavioral, and cognitive regulation influence one's capacity for self-regulated learning strategies (surface and deep processing, engagement, and organization), which ultimately results in higher achievement (conceptualized here in terms of classroom achievement) (see Fig. 1). Moreover, we expect these processes to operate somewhat differently depending on students' liking of the learning contexts (favorite versus least favorite courses) and across development (high school versus college).

While there are some regulatory processes that can be considered universal (Winne and Nesbit 2010), we hypothesize that learning is situated within specific contexts and that the deployment of regulatory resources may vary depending on the context (e.g. Ben-Eliyahu and Linnenbrink-Garcia 2013). Here, we define context based on students' liking (or disliking) of a course and hypothesize that greater employment of affective, behavioral, and cognitive regulation may be required in disliked learning contexts. Although studies have not directly compared the relations of regulatory processes to strategy use and learning in educational contexts based on preference, research points to a breakdown of self-regulation when one feels negative emotions so much that negative emotionality was found to impair attention, memory, and problem solving (see Blair 2002; Tice, Baumeister, and Zhang 2008). Thus, we hypothesized that students would need to regulate more in their disliked courses in order to attend class, employ learning strategies, and persist towards higher achievement.

Furthermore, findings about emotions in education point to a general facilitative effect of positive emotions (e.g., Pekrun and Linnenbrink-Garcia 2012).[1] Thus, it is reasonable that within positively valenced contexts – such as favorite courses – students can more easily reach optimal learning and there may not be as strong of a connection between the regulation of affect, behavior, and cognition and learning strategies. On the other hand, disliked situations may require greater efforts to reappraise, shift attention towards the task, and instigate and maintain behaviors; and thus the ability to engage in these types of regulation would be crucial for employment of specific learning strategies (e.g., deep processing) and engagement more broadly. Thus, we hypothesize that affective, behavioral, and cognitive regulation are called upon more in disliked contexts. And, as such, these forms of regulation will be stronger predictors of self-regulated learning strategies and subsequent achievement in least favorite courses. At the same time, it is important to note that the patterns may be more complex than these general hypotheses suggest. Harnessing regulatory capacities towards effective affective, behavioral, and cognitive regulation depletes regulatory resources (Schmeichel and Baumeister 2004). Thus in least favorite courses, effective regulation may be a "double-edged sword." While effective regulation should lead to adaptive learning processes, the increased challenges of regulating affect, behavior, and cognition in disliked classes may deplete resources in such a way that one is not able to effectively implement self-regulated learning strategies. Thus, we remain open to other possible patterns of findings as well.

With respect to development, our investigation of age-related differences was somewhat exploratory. Building on prior research suggesting that younger people are more novice

[1] However, some research suggests that there might be advantages to some negative emotions, such as confusion, that fuels engagement in specific situations (D'Mello and Graesser 2014).

regulators (Pintrich and Zusho 2002), we hypothesized that college students would be more adept regulators in comparison to high school students, resulting in higher levels of affective, behavioral, and cognitive regulation as well as stronger relations between these forms of regulation and subsequent self-regulated learning strategies and achievement. Additionally, the increased independence and expectations for self-direction experienced by college students suggest that behavioral regulation, in particular, may be more strongly associated with self-regulated learning strategies among college students. We tested this theoretical path model using structural equation modeling (SEM) (see Fig. 2 for saturated SEM) across two learning settings (favorite and least favorite courses) in high school and college students.

Method

Participants

Participants were high school (n=178) and college students (n=280) from the southeastern United States, who were queried about their use of regulation in their favorite and least favorite courses midway through the semester. In order to decrease non-age related demographic differences between these two groups of participants, only high school students identified as college bound by their school administrators and teachers were offered the opportunity to participate in the study. Additionally, only sophomores and juniors[2] were surveyed. Within the college sample, 81 % were sophomores and 19 % were juniors; among high school students, 42 % were sophomores and 58 % were juniors. High school students mean age was 15.88 (SD=0.70) and college students were older, with a mean age of 19.49 (SD=0.77).

In terms of participant demographic characteristics, participants in both samples were somewhat racially diverse and approximately half were female (64 % of high school participants and 46 % of college participants). In the high school sample, the majority of participants (55 %) reported their race or ethnicity as White/Caucasian, 19 % as African-American/Black, 4 % as Asian-American/Asian, and 3 % as Latino; one participant was Native American and 6 % reported their race or ethnicity as Mixed or Other. The college sample was even more ethnically diverse: 47 % reported their ethnicity as White/Caucasian, 12 % were African-American/Black, 27 % Asian-American/Asian, 7 % Latino, 1 % Native American, less than 1 % Middle Eastern, 1 % were either “mixed” or “other”, and 3 % did not report their race.

Procedure

High school and college students were recruited through their respective academic institutions. For the high schools, consent forms and fliers about the study were posted and distributed targeting college-bound students; only students who received parental consent were allowed to complete the survey, which they completed outside of class. Seventy-four percent of the high school surveys were completed online and the rest were paper surveys. High school participants were compensated $10 for their participation. University student recruitment and participation was through the university psychology subject pool, and participants signed up

[2] In the United States, high school and college are 4 years. Sophomores are 2nd year students and juniors are 3rd year students. In order to ensure that participants were stable in their respective learning contexts, we opted to exclude 1st year Freshmen who were transitioning into high school/college or 4th year Seniors who were leaving school.

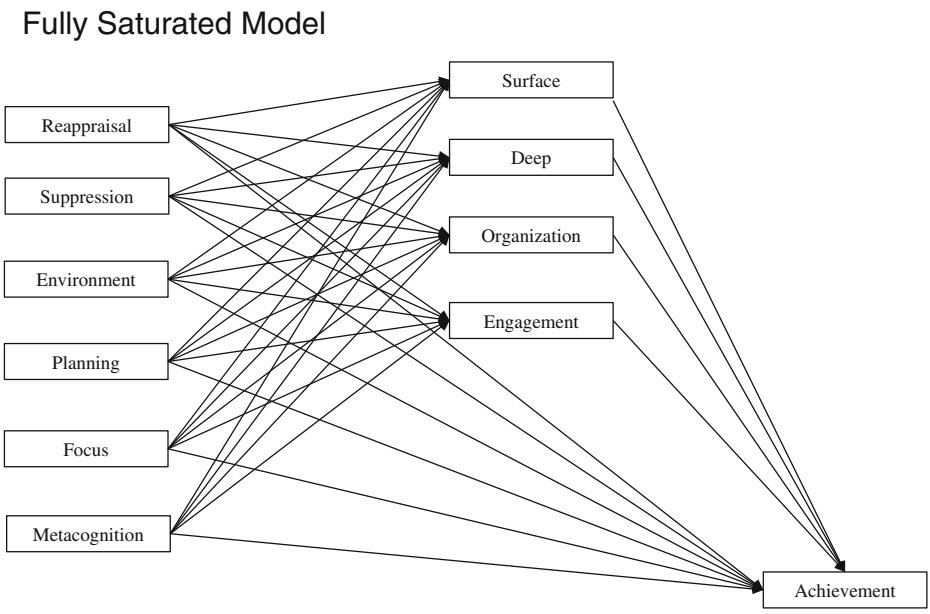

Fig. 2 Fully saturated mediational model tested separately for high school and college students across favorite and least favorite courses

online and answered an online survey. College students received one subject pool credit for participation.

The survey consisted of three sections: the first two sections queried students about their favorite and least favorite classes followed by a third section with questions focused on demographic information. For the first part of the survey, students were asked to identify their favorite course ("What is your favorite class?"). The course that they nominated as favorite was then used as the course reference throughout this first part of the survey. The second section was identical to the first except that the first focused on favorite courses and the second on least favorite courses. The favorite course part of the survey always appeared first. This was done out of concern that completion of the least favorite part first would prime negative affect, thoughts, and dispositions, and perhaps influence responses and participation negatively (Tice et al. 2008).

Measures

Prior to running the path models, we investigated the assumptions for structural equation models (Kline 2012) and found that, with the exception of achievement, all of the measured variables were approximately normal. Since achievement was not normally distributed in both samples, we squared the values for all participants.[3] We also confirmed that multi-collinearity was within acceptable range (below 0.8) by investigating the correlations (see Tables 1 & 2).

[3] For achievement, skewness was slightly high for both favorite (−1.67; −1.84) and least favorite (−1.14; −2.03) courses for high school and college, respectively; kurtosis was high in favorite courses (2.79) for high school and in both favorite (2.99) and least favorite (4.65) courses for college students. Squaring the values decreased the skewness to −0.78 and −1.52 for favorite courses and −0.29 and −0.80 for least favorite courses, for high school and college students, respectively and the kurtosis to −0.43 for favorite courses for high school students and 1.49 in favorite and −0.05 in least favorite courses for college students.

Next, we confirmed the independence of each scale and measurement invariance across the participant populations (high school and college) and contexts (favorite and least favorite courses) using confirmatory factor analysis (CFA). Because we had a within-subject design, we could not use a chi-square analysis to compare a constrained with an unconstrained CFA model across contexts. While it would be possible to compare age groups using this approach, our sample size was too small for comparing the unconstrained to the constrained models.[4] We therefore used the Standardized XY coefficient, which are standardized parameter estimates that use both the variance of the independent and dependent variables, to investigate the general factor structure from the CFA within context and across age group differences (similar to Ben-Eliyahu and Linnenbrink-Garcia 2013). The underlying scale structure for regulation in favorite and least favorite courses for high school and college students was generally similar despite small variations in the relative strength of the item loadings. The measurement model for affective, behavioral, and cognitive regulation measures and for the learning strategies showed good model fit across contexts and age groups (except for the single CFA for affective, behavioral, cognitive regulation in high school favorite courses; see Table 3). Other than achievement, all responses were on a 5-point scale, ranging from 1, strongly disagree, to 5, strongly agree. All questionnaire items appear in the Appendix.

Emotion regulation Emotion regulation was measured using two established scales developed by Gross and John (2003) tapping into the ability to reframe the situation in order to adjust emotions (i.e., *reappraisal*) and inhibition of emotional expression (i.e., *suppression*). Five items were used to assess reappraisal (sample item: "When I want to feel more positive emotion, I change the way I'm thinking about the situation"); all reliabilities across contexts were above 0.80 (see Table 4). Three items were used to assess suppression (sample item: "I keep my emotions to myself"). The reliabilities for this scale were somewhat lower (see Table 4), but still within an acceptable range.

Behavioral regulation To assess behavioral regulation, we measured both *environmental* regulation (e.g., the ability to choose and adjust one's location so that it is conducive to learning; Zimmerman 2000) and the ability to *plan* one's time (Pintrich et al. 1991). A seven-item environmental regulation scale was developed for this study (sample item: "I usually study in a place where I can concentrate on my work in [(least) favorite course]"). To assess planning, we used seven items adapted from Xu (2008) and the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al. 1991; sample item: "I set a plan for how to go about completing my assignments in [(least) favorite course]"). Reliabilities across contexts for both scales were high (see Table 4).

Cognitive regulation Cognitive regulation was conceptualized in terms of both the ability to *focus* on the tasks at hand and *metacognition* (e.g., the monitoring and adjustment of cognitions in general). Focus was assessed using four items composed for this study; a sample item for the focus scale is "I have a hard time concentrating in [(least) favorite course]." Items for the focus scale were reverse coded so that it was consistent with the rest of the regulation measures in that higher scores indicate adaptive regulation. Metacognition was assessed using seven items from the MSLQ (Pintrich et al. 1991) that combine the monitoring and adjustment

[4] Traditionally, ten participants per parameter are required as a minimum for CFA. When running the unconstrained model, we encountered an unidentified model because the number of paths were doubled for the multigroup unconstrained model, suggesting that we did not have a sufficient sample size to analyze the data using an unconstrained model (Ho 2006; Muthén and Muthén 1998).

Table 1 High School – Bi-variate correlations for self-regulation and achievement

	Reappraisal	Suppression	Environment	Planning	Metacog	Focus	Deep	Surface	Organization	Engagement	GPA
Reappraisal	0.67	0.33	0.48	0.42	0.48	0.05	0.35	0.38	0.38	0.21	−0.13
Suppression	0.30	0.51	0.15	0.13	0.09	0.17	0.01	0.21	0.10	0.05	−0.05
Environment	0.38	0.12	0.64	0.71	0.66	0.24	0.50	0.50	0.55	0.41	0.03
Planning	0.29	0.07	0.73	0.63	0.58	0.35	0.55	0.53	0.54	0.54	0.19
Metacognition	0.46	0.11	0.70	0.70	0.60	0.23	0.46	0.43	0.54	0.45	0.01
Focus	0.17	0.11	0.24	0.21	0.18	0.38	0.31	0.22	0.17	0.55	0.21
Deep	0.39	−0.01	0.57	0.59	0.65	0.25	0.58	0.41	0.48	0.55	0.16
Surface	0.38	0.12	0.56	0.56	0.66	0.17	0.61	0.55	0.49	0.44	−0.00
Organization	0.37	0.01	0.50	0.57	0.58	0.17	0.58	0.55	0.73	0.22	−0.10
Engagement	0.36	0.02	0.54	0.55	0.59	0.54	0.69	0.57	0.37	0.45	0.33
GPA	0.03	0.07	0.07	0.13	0.03	0.19	0.14	0.09	−0.10	0.24	0.58

Above diagonal are the correlations for favorite courses. Below diagonal are correlations for least favorite courses. The diagonal is the correlation between favorite course and least favorite course

Table 2 College– Bi-variate correlations for self-regulation and achievement

	Reappraisal	Suppression	Environment	Planning	Metacog	Focus	Deep	Surface	Organization	Engagement	GPA
Reappraisal	0.53	0.10	0.38	0.26	0.37	0.09	0.25	0.23	0.21	0.20	−0.08
Suppression	0.26	0.45	0.06	−0.03	−0.05	0.02	−0.09	0.00	−0.14	−0.13	−0.10
Environment	0.38	0.17	0.62	0.57	0.52	0.25	0.46	0.27	0.29	0.37	0.06
Planning	0.24	0.07	0.65	0.60	0.55	0.31	0.48	0.26	0.43	0.50	0.16
Metacognition	0.31	0.09	0.60	0.58	0.43	0.30	0.51	0.37	0.35	0.43	0.09
Focus	0.11	0.07	0.33	0.29	0.42	0.19	0.37	0.06	0.12	0.56	0.08
Deep	0.29	0.14	0.53	0.53	0.63	0.37	0.44	0.37	0.40	0.59	0.18
Surface	0.23	0.09	0.41	0.49	0.59	0.27	0.54	0.30	0.51	0.21	0.01
Organization	0.18	−0.05	0.34	0.46	0.53	0.19	0.51	0.69	0.47	0.30	0.06
Engagement	0.19	0.05	0.50	0.57	0.61	0.64	0.62	0.49	0.39	0.42	0.21
GPA	0.12	−0.13	0.07	0.11	0.06	0.14	0.17	0.06	0.06	0.16	0.29

Above diagonal are the correlations for favorite courses. Below diagonal are correlations for least favorite courses. The diagonal is the correlation between favorite course and least favorite course

Table 3 Fit statistics for confirmatory factor analyses for high school and college students in favorite and least favorite courses

	Chi-Sq	CFI	TLI	RMSEA	SRMR
Affective, behavioral, cognitive regulation					
Favorite course					
High school	3085.74	0.88	0.87	0.06	0.07
College	736.90	0.92	0.91	0.05	0.06
Least Favorite Course					
High school	717.65	0.91	0.90	0.06	0.06
College	868.55	0.92	0.91	0.06	0.06
Learning strategies					
Favorite course					
High school	213.67	0.90	0.88	0.07	0.08
College	221.79	0.91	0.90	0.06	0.07
Least Favorite Course					
High school	182.07	0.93	0.92	0.06	0.06
College	219.99	0.94	0.92	0.06	0.05

components of metacognition (sample item: "I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying"). Reliabilities across contexts for both the focus and metacognition scales were within an acceptable range (see Table 4).

Self-regulated learning strategies Self-regulated learning strategies were conceptualized as *deep* and *surface* processing, *organization*, and behavioral-cognitive *engagement*. Separate scales were used to assess each self-regulated learning strategy adapted from Pintrich et al. (1991). More specifically, five items assessed deep processing (sample item: "I try to apply or use ideas from class assignments or readings in other class activities such as lecture, discussion, or groupwork"), which was conceptualized as making connections across subjects and within the same subject.

Table 4 Reliability cronbach alpha for self-regulated learning scales

	Favorite		Least favorite	
	High school	College	High school	College
Reappraisal	0.84	0.87	0.89	0.90
Suppression	0.82	0.75	0.82	0.78
Environment	0.85	0.81	0.89	0.91
Planning	0.85	0.83	0.86	0.88
Metacognition	0.77	0.73	0.85	0.84
Focus	0.81	0.81	0.86	0.86
Deep	0.84	0.78	0.84	0.81
Surface	0.71	0.65	0.75	0.72
Organization	0.80	0.74	0.79	0.82
Engagement	0.74	0.68	0.66	0.76

Surface processing, such as rehearsal, was assessed using three items (sample item: "When I study for [(least) favorite course], I practice saying the material to myself over and over"). Organization refers to the use of aides such as highlighting to organize the learning materials in order to facilitate learning. It was assessed with four items such as "I make simple charts, diagrams, or tables to help me organize the class material." Academic-behavioral engagement was assessed using five items from Assor et al. (2002), such as "I skip [(least) favorite course]". Reliabilities for these measures were generally acceptable, although some reliabilities for surface processing and engagement were slightly below traditional acceptable cut-offs of 0.70 (see Table 4).

Achievement Achievement was measured as the grade received in each course, which was obtained from school records for high school students and from self-reports for college students. While it would have been preferable to obtain achievement from school records for college students, prior research shows that self-reported achievement are a reasonable proxy when official academic records are unavailable (Dornbusch et al. 1987; Gray and Watson 2002; Noftle and Robins 2007). All grades were converted to a 4-point scale with 4 signifying an A or A+ and 0 an F or withdrawal.

Analysis plan

The results are presented in two main sections. We first present descriptive statistics and correlations followed by the structural equation model findings. The same structural equation model was examined separately for each course type by age group using unweighted scale scores for each construct. Based on our theoretical model, we investigated whether affective, behavioral, and cognitive regulation were related to learning strategies, which were in turn associated with achievement. These paths were tested in one model across context by age group for a total of four identical models.

Results

Descriptive statistics

As a first step, we report the means, standard deviations, and correlations for all of the regulatory capacities (see Tables 1, 2, 5, and 6). Using a generalized linear model to compare within- and between-group effects, there were significant differences between high school and college students (Wilks' Lambda (11, 332)=16.73, $p<0.001$), between favorite and least favorite courses (Wilks' Lambda (11, 332)=37.00, $p<0.001$), and an interaction between type of course and age (Wilks' Lambda (11, 332)=4.15, $p<0.001$). In order to account for the multiple comparisons, we used a Bonferroni correction.

In comparing favorite and least favorite courses (see Table 5), there were significant differences for reappraisal, environmental regulation, planning, metacognition, focusing, deep processing, surface processing, organization, engagement, and achievement. The means, standard deviations, and effect sizes comparing students' responses for their favorite and least favorite courses are reported in Table 5. Overall, higher levels of self-regulation were reported in favorite courses. Specifically, in favorite classes, students reframed situations in a more positive light by using reappraisal more than in least favorite classes. Students also adjusted their study location and planned when and what to study more in their favorite course than in their least favorite classes. Metacognition and

Table 5 Mean, standard deviation, and Cohen's *d* for favorite and least favorite courses

	Favorite		Least Favorite		*F*-Value	Cohen's *d*
	Mean	SD	Mean	SD		
Reappraisal	3.10	0.78	2.97	0.83	11.43**	0.18
Suppression	3.33	0.95	3.37	0.90	0.09	0.04
Environment	3.60	0.70	3.36	0.82	45.04**	0.37
Planning	3.63	0.71	3.41	0.78	39.40**	0.34
Metacognition	3.56	0.55	3.29	0.70	58.76**	0.43
Focus	3.60	0.76	2.65	0.89	294.50**	0.95
Deep	3.76	0.76	3.31	0.82	111.68**	0.59
Surface	3.51	0.91	3.36	0.93	7.40**	0.15
Organization	3.04	0.95	2.90	0.94	10.10**	0.16
Engagement	4.04	0.55	3.46	0.73	203.08**	0.85
Achievement	3.43	0.74	3.03	0.99	80.51**	0.47

Degrees of freedom for all test were 1, 342 for all *F*-values

cognitive focusing were also higher for favorite classes. Students also reported using a variety of learning strategies, including both deep and surface level processing, organization, and engagement, more in favorite than least favorite courses. Given these higher levels of adaptive processing in favorite courses, it is not surprising that higher achievement was reported for favorite courses.

In looking at age-related differences (Table 6), there were significant differences between high school and college students for reappraisal, environmental regulation, planning, deep processing, organization, engagement, and achievement. High school students were more likely to use reappraisal strategies and were more engaged in their academics. As hypothesized, college students reported higher levels of environmental regulation and planning. College students also reported higher levels of organization and achievement than high school students.

Table 6 Mean, standard deviation, and Cohen's *d* for high school and college students

	High School		College		*F*-Value	Cohen's *d*
	Mean	SD	Mean	SD		
Reappraisal	3.18	0.78	3.01	0.67	6.63*	0.23
Suppression	3.29	0.85	3.43	0.76	0.86	0.17
Environment	3.39	0.73	3.56	0.65	6.61*	0.25
Planning	3.44	0.72	3.58	0.21	6.32*	0.21
Metacognition	3.46	0.60	3.40	0.52	0.09	0.11
Focus	3.19	0.71	3.11	0.63	1.03	0.12
Deep	3.49	0.76	3.58	0.63	4.75*	0.13
Surface	3.49	0.82	3.38	0.71	0.39	0.14
Organization	2.85	0.91	3.09	0.77	9.08**	0.28
Engagement	3.91	0.50	3.62	0.57	46.79**	0.54
Achievement	3.01	0.89	3.39	0.55	22.07**	0.51

Degrees of freedom for all test were 1, 342 for all *F*-values

There were also significant course type by age interactions for suppression (F (1, 342)= 8.99, p=0.003, focusing (F (1, 342)=4.06, p=0.045), and engagement (F (1, 342)=19.74, p<0.001), thus qualifying the previously reported main effects for these variables. Although high school students reported using more suppression in their favorite course (M=3.38, SD= 1.04) than least favorite course (M=3.24, SD=0.93), these differences were not significant. For college students, however, the pattern was significant and reversed (Cohen's d=0.19, p=0.012) with more suppression reported in least favorite (M=3.47, SD=0.86) than favorite courses (M=3.30, SD=0.88). In terms of cognitive focusing, both high school and college students reported higher levels of focusing in their favorite courses ($M_{high\ school}$=3.58, $SD_{high\ school}$= 0.79; $M_{college}$=3.62, $SD_{college}$=0.75) relative to their least favorite courses ($M_{high\ school}$=2.76, $SD_{high\ school}$=0.88; $M_{college}$=2.58, $SD_{college}$=0.90). However, the decrease in focusing for least favorite courses was somewhat larger for college student (Cohen's d_{College}=0.99, p_{College}< 0.001) relative to high school students (Cohen's $d_{\text{HighSchool}}$=0.88, $p_{\text{HighSchool}}$<0.001). A similar pattern was also observed for engagement. Both high school and college students reported higher engagement in their favorite courses ($M_{high\ school}$=4.10, $SD_{high\ school}$=0.55; $M_{college}$= 4.00, $SD_{college}$=0.56) than least favorite courses ($M_{high\ school}$=3.71, $SD_{high\ school}$=0.59; $M_{college}$=3.28, $SD_{college}$=0.77), but college students (Cohen's d_{College}=1.01, p_{College}<0.001) reported substantially lower engagement than high school students (Cohen's $d_{\text{HighSchool}}$=0.65, $p_{\text{HighSchool}}$<0.001) in their least favorite classes.

Correlations for the different components of self-regulation are presented in Tables 1 and 2 for the high school and college samples, respectively. Interestingly, the only significant associations with achievement were with planning, focusing, and engagement across both course types. As hypothesized, the different forms of self-regulation were associated with each other in both course types, but stronger correlations were found in least favorite courses. Notably, as seen in the diagonal, the same self-regulatory capacity in favorite courses was associated with its use in least favorite courses. However, these correlations are surprisingly small (< 0.7) considering these are compared using the exact same surveys, suggesting that regulation varies by course type. Most interesting is the relatively small correlation of cognitive focusing across favorite and least favorite classes ($r_{\text{HighSchool}}$=0.38, p<0.001; r_{College}=0.19, p=0.002), especially among college students.

Primary analyses: Structural equation model

Our primary analyses consisted of four identical path models for course type (favorite and least favorite) by age group (high school and college) conducted using structural equation modeling (SEM). The model investigated whether affective, behavioral, and cognitive regulation were related to learning strategies and subsequent achievement (see Fig. 2). Because of the within-group design, we could not employ multi-group comparisons. However, an identical fully saturated model was tested on the mean unweighted scale score, and we investigated direct and indirect effects using the Standardized XY coefficients so that we could compare across courses and age-groups. As described below, the findings from the path analyses suggest that there are slight differences in the way that aspects of regulation relate to learning strategies and achievement across contexts and age groups.

With respect to emotion regulation, reappraisal (reframing situations) was only positively related to learning strategies for high school students (see Table 7), while suppression was negatively associated with learning strategies across both course types for high school and in favorite courses for college students. More specifically, reappraisal was positively associated with deep processing in favorite and least favorite courses and with organization only in least favorite courses for high school students. However, not expressing one's emotions, i.e., suppression, was related to lower levels of

self-regulated learning strategies for both high school and college students. For high school students, emotional suppression was negatively related with deep processing, whereas for college students, suppression was negatively related with organization and engagement in favorite courses, but was unrelated in least favorite courses.

In terms of behavioral regulation, the ability to adjust one's study environment (location) was related to deep processing, but only for college students in favorite courses. Planning was more consistently positively associated with learning strategies across both learning contexts for both age groups, though slightly differently. Whereas for high school students, planning was positively related to all forms of self-regulated learning strategies in favorite courses, it was only related to deep processing and organization in least favorite courses. For college students, planning was positively associated with all forms of self-regulated learning strategies across both learning contexts, except surface processing in favorite courses (see Table 7).

Both of the cognitive regulatory processes, metacognition and focusing, were positively associated with learning strategies in favorite and least favorite courses for both age groups, though the role they played differed slightly depending on the context and/or age group (see Table 7). Most consistently, metacognition was positively associated with all forms of learning strategies for both high school and college students in their least favorite course. For high school students in favorite courses, metacognition was associated with organization. For college students, metacognition was associated with surface and deep processing. For high school students in favorite courses and college students in both favorite and least favorite courses, cognitive focusing was positively associated with deep processing and engagement, whereas for high school students in least favorite courses, focusing was associated only with engagement.

We next considered the direct effects of all regulatory processes to achievement. Somewhat surprising and contrary to our hypotheses, emotion regulation was related to achievement only for college students. And, even more surprising, reappraisal was negatively related to achievement in favorite courses. More in keeping with our hypotheses and replicating previous work by Gross and John (2003), suppression was negatively related to college students' achievement in least favorite courses only. There were no other direct effects of achievement on emotion regulation. With respect to behavioral regulation, planning was positively related to achievement for high school students, but not college students, across both favorite and least favorite courses. Neither location nor the two cognitive regulation strategies (focus, metacognition) significantly related to achievement for any class type or age level.

Contrary to our hypotheses, there were also relatively few direct effects of the learning strategies on achievement. In favorite courses, engagement was positively associated with achievement for high school and college students. Surprisingly, high school students in their least favorite course who employed an organizational self-regulated learning strategy received lower achievement, suggesting that organization detracts from rather than facilitates achievement in disliked learning situations. While the correlation was -0.10, it increased when controlling for all other variables in the model to -0.35, suggesting that this result only occurs after controlling for the other forms of self-regulation and self-regulated learning strategies.

Indirect paths from regulation to achievement through self-regulated learning strategies

Our final set of analyses investigated indirect paths from affective, behavioral, and cognitive regulation through learning strategies to achievement using MacKinnon's (2008) guidelines for testing statistical mediation. Indirect and direct paths were examined based on MacKinnon's (2008) assertion that "a mediated effect may exist whether or not there is a

Table 7 Standardized coefficients for SEM for high school students in favorite courses

	Surface	Deep	Organization	Engagement	Achievement
High School – Favorite					
Reappraisal	0.10	0.16*	0.08	−0.04	−0.16
Suppression	0.11	−0.13*	0.00	−0.11	0.04
Environment	0.17	0.11	0.19	−0.07	−0.08
Planning	0.27**	0.30***	0.23*	0.24*	0.31**
Metacog	0.10	0.12	0.24**	0.13	−0.06
Focus	0.05	0.17**	−0.01	0.45***	−0.03
Deep					0.17
Surface					−0.10
Organization					−0.17
Engagement					0.25*
High School – Least Favorite					
Reappraisal	0.09	0.15*	0.17*	0.06	0.01
Suppression	0.02	−0.13*	−0.09	−0.08	0.06
Environment	0.11	0.10	0.03	0.11	−0.07
Planning	0.14	0.21*	0.30**	0.08	0.25*
Metacog	0.44***	0.36***	0.28**	0.23**	−0.15
Focus	0.02	0.10	0.00	0.51***	0.11
Deep					0.21
Surface					0.09
Organization					−0.35**
Engagement					0.06
College – Favorite					
Reappraisal	0.08	0.04	0.09	0.05	−0.16*
Suppression	0.01	−0.09	−0.13*	−0.12*	−0.07
Environment	0.06	0.19**	0.02	0.03	−0.03
Planning	0.06	0.16*	0.33***	0.17**	0.12
Metacog	0.30***	0.25***	0.13	0.05	−0.00
Focus	−0.07	0.20***	−0.03	0.48***	−0.09
Deep					0.16
Surface					−0.01
Organization					−0.04
Engagement					0.18*
College – Least Favorite					
Reappraisal	0.04	0.07	0.05	−0.02	0.13
Suppression	0.03	0.05	−0.10	−0.05	−0.19**
Environment	−0.04	0.10	−0.08	0.03	−0.03
Planning	0.23***	0.19**	0.26***	0.22***	0.05
Metacog	0.46***	0.39***	0.44***	0.17**	−0.14
Focus	0.02	0.11*	−0.04	0.50***	0.10
Deep					0.16
Surface					−0.01
Organization					−0.02
Engagement					0.08

statistically significant effect of the independent variable on the dependent variable" (p. 55). That is, in order for a mediation to occur, there need to be two significant relations: 1) between the independent variable (motivation) to the mediator (self-regulation); and 2) between the mediator (self-regulation) and the dependent variable (academic outcomes). Using this strategy, we tested for direct paths between variables and the total indirect path and its significance. The statistically significant indirect paths are depicted in Fig. 3. In favorite courses, focusing led to higher achievement through engagement for high school ($\beta=0.12$, $p=0.012$) and college students ($\beta=0.09$, $p=0.035$). In least favorite courses, and only for high school students, planning and metacognition were negatively related to achievement through organization. Specifically, both planning and metacognition were positively associated with using organizational strategies, which were in turn associated with lower achievement ($\beta=-0.11$, $p=0.028$ for planning; $\beta=-0.10$, $p=0.033$ for metacognition).

Discussion

The findings from the current study provide preliminary empirical support for our theoretical framework (Fig. 1), suggesting that different forms of self-regulation are interrelated in learning settings. Specifically, we tested whether affective, behavioral, and cognitive regulation were associated with learning strategies, and in turn, achievement. While we found some evidence for the proposed pathways, there were not as many direct or indirect pathways to achievement as expected. Additionally, the pattern of findings varied across contexts and age groups, suggesting that it is critical to situate the learner within a specific learning context (Efklides 2011). Overall, these findings provide insight into how an integrative model of self-regulation might function among adolescents and young adults. However, given the complexity of patterns across contexts, it is important that future work replicate these results.

Relation of affective, behavioral, and cognitive self-regulation to achievement through self-regulated learning strategies

In line with Schunk's (2008) charge to include achievement as an outcome, our main research question was concerned with the indirect pathways from self-regulation of affect, behavior, and cognition to self-regulated learning strategies to achievement. Although there were relatively few statistically significant indirect paths between affective, behavioral, and cognitive regulation and

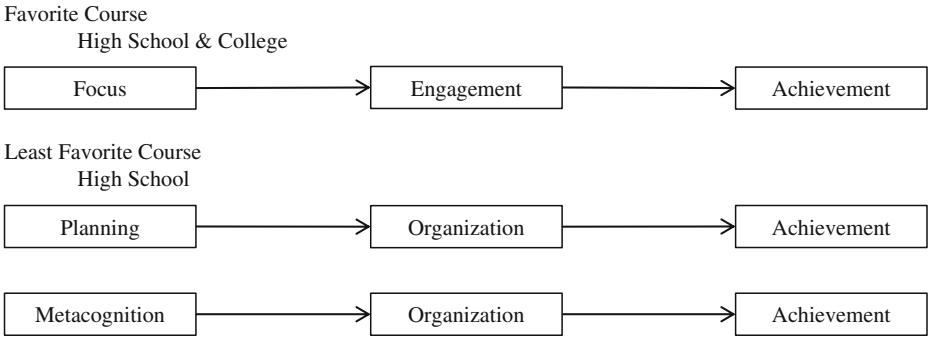

Fig. 3 Statistically significant mediational path models. Solid arrows depict positive relations and dashed lines signify negative relations

achievement via learning strategies, we found some support for our model and observed somewhat different patterns of self-regulation depending on age and context. First, we found a consistent pattern in favorite courses for both high school and college students whereby cognitive focusing was positively associated with engagement and subsequent achievement.

However, a different pattern emerged in least favorite courses. For college students, there were no statistically significant indirect effects from affective, behavioral, and cognitive regulation to achievement via learning strategies in least favorite courses. For high school students, however, planning and metacognition were positively associated with organization, which was in turn associated with lower achievement. However, in addition to this negative indirect effect of planning on achievement, there was also a positive direct effect of planning on achievement.

This pattern of findings for high school students in least favorite courses was unexpected. Our results suggest that, in disliked courses, the use of planning and metacognition may adaptively lead to organization; however, organization may be done ineffectively. Ineffective organization may be colored by negative emotions, a desire to avoid engagement with the learning materials, and an attempt to set behavioral benchmarks for the work, especially if these are mandatory courses that student have to take but do not like. One reason that organization may be ineffective is that the use of cognitive and behavioral regulation in disliked courses may deplete regulatory capacities (Schmeichel and Baumeister 2004) to the extent that it is detrimental to other processes (i.e., learning strategies). Another possibility is that organization may be used excessively, possibly serving as a self-handicapping strategy. In keeping with this idea, there is evidence that time studying is not related to achievement (Nandagopal and Ericcson 2012; Plant et al. 2005), suggesting that some of the time that is allotted for studying may in fact not be used adaptively, as in over-organizing. Students who spend time organizing their study materials, outlining their materials, writing summaries, and making diagrams or charts may run out of real study time thereby not really *learning* the materials. Another possibility is that these are especially difficult courses that result in lower achievements, despite unsuccessful attempts at organizing the materials for studying. More research is needed to determine whether organization could become ruminative in nature, and in doing so, become maladaptive.

In addition to the full pathway from self-regulation to learning strategies to achievement, we also considered the direct relations of the three forms of self-regulation (emotional, behavioral, cognitive) to learning strategies. With respect to emotion regulation, reappraisal (reframing situations) was positively related only to learning strategies for high school students. Moreover, it was negatively related to achievement for college students in favorite courses. This pattern of findings is somewhat unexpected. Given prior research suggesting that reappraisal is positively related to learning (Gross and John 2003) and that the regulation of emotions increases with age (McRae et al. 2012), we expected that reappraisal would be a more effective emotion regulation strategy for college students. It may be that reappraisal becomes a sort of self-talk whereby students are able to go through the motions but do not necessarily process information. While no real processing is done, there is a sense of security since overall the student likes the topic or course in general.

Our findings for suppression were more in line with previous work (Gross and John 2003). Specifically, not expressing one's emotions (i.e., suppression) was related to lower levels of learning strategies for college and high school students regardless of course type. The pattern was less consistent with respect to achievement: suppression was negatively related to achievement, but only for college students in least favorite courses. Thus although Ben-Eliyahu and Linnenbrink-Garcia (2013) recently found that there may be benefits in suppressing emotions for emotional experiences in disliked classes, the same benefit does not appear to carry over to learning processes. Suppressing emotions may be detrimental to employing learning strategies because it is more taxing on regulatory resources than reappraisal. That is, with suppression, the

student does not cope with the negative emotion, making the possibility of it resurfacing more likely (Tice et al. 2008). Because suppression does not adjust the negative emotion, regulatory resources are continuously harnessed towards consistent suppression possibly depleting regulatory resources from going towards learning strategies. One would also expect that this would undermine actual learning, but we have very limited evidence to suggest that this is the case. While the findings relating suppression to learning strategies were consistent across age and context, the other patterns varied suggesting that future research may need to more closely consider the developmental stage and emotional reactions to the learning context.

In terms of behavioral regulation, as hypothesized, the ability to adjust one's study environment was related to deep processing, but only for college students in favorite courses. College students, who may have more flexibility in choosing their location of study than high school students, use more environmental regulation than high school students. Such liberty affords deeper processing. As with homework completion (Xu and Wu 2013), planning when and what to study, or managing one's work outside of the course, was more consistently positively associated with learning strategies for both age groups and across both learning contexts, suggesting that allotting time to study is useful for implementing study strategies. Somewhat surprisingly, however, planning was only positively related to achievement for high school, but not college students. This was unexpected, as we expected the greater autonomy associated with college to heighten the benefit of planning for learning.

Finally, we considered how cognitive regulation related to learning strategies and achievement. As in prior work, knowledge about how cognition works and the ability to monitor such knowledge building was associated with efforts to organize the learning materials for optimal learning (Pintrich and Garcia 1991; Vrugt and Oort 2008). Both metacognition and cognitive focusing were positively associated with learning strategies for college and high school students in favorite and least favorite courses, though slightly differently depending on the context and/or age group. Most consistent, metacognition was positively associated with organization for all age groups across both types of courses, and focusing was positively related to engagement. Despite these benefits of cognitive regulation for employing learning strategies, there were no direct relations between cognitive regulation and achievement.

Age group differences

Although not a primary focus of our study, we found interesting results when comparing the age groups. In particular, high school students reported higher use of reappraisal and engagement. That is, overall, high school students were more engaged in their courses and tended to reframe learning situations in a positive light. In examining junior high, high school, and college students, Bakracevic Vukman and Licardo (2010) found similar patterns whereby younger students reported greater use of cognitive, metacognitive, emotional, and motivational self-regulation in learning in comparison to older students. However the increased use of emotional regulation is less consistent with recent research by McRae et al. (2012), who compared older children (10–13), adolescents (14–17) and young adults (18–22) and found that emotion regulation use increased with age. More work is needed to decipher whether this trend exists throughout development and what leads to these reports. For instance, are they reflective of actual usage or are younger students' self-perceptions less accurate than older students so that their awareness of self-regulation is augmented? One possibility is that younger students overuse regulation without real forethought. Additionally, McRae et al. (2012) study used behavioral data and fMRI data, while our data was self-reported. A mixed method study would shed further light on the interrelations of these processes. More work is also needed to compare high school and college students longitudinally, taking into account development of self-perceptions and social desirability in

reporting. Another possibility is that older students may have more self-regulation processes at their disposal so that they are able to fine tune their use of regulatory capacities to the situation at hand, though more research is needed to understand whether older students selectively use particular strategies differently than younger or more novice students.

Contextual differences

We also considered differences in self-regulation between favorite and least favorite courses. In contrast to our hypotheses, participants reported greater use of self-regulation in favorite courses. This might be an indicator that students are more invested in their favorite courses and therefore deliberately regulating towards succeeding in them. Another possibility is that coping with a least favorite course context depletes the learner's regulatory resources and therefore less energy is invested in regulating (Schmeichel and Baumeister 2004; Tice et al. 2008). That is, in disliked courses, students may just "bite the bullet" and try to get through class time without investing in self-regulated learning since their regulatory resources are invested in holding on and getting through the course, thereby depleting resources available for other forms of regulation (Ben-Eliyahu and Bernacki 2015; Schmeichel and Baumeister 2004). Finally, it is not surprising that higher achievement were reported in favorite courses, as it could be that interest in favorite courses is initially higher thereby supporting learning. However, there may be other reasons for liking courses, such as liking the teacher, enjoying the tasks, having good friends in the course, or an easy grading structure, all of which could contribute to higher achievement. More research is needed to evaluate what leads students to favor courses and whether it matters why students like a specific course.

Notably, there were some interesting interaction effects between course type and age. High school students reported greater use of suppression in their favorite courses, while college students used suppression more in least favorite courses. This pattern of findings is not clear and more research is needed to investigate why this would occur. In line with our hypotheses, higher levels of focusing and engagement were reported in favorite courses compared to least favorite courses, but college students reported lower levels of focusing in least favorite courses compared to high school students. Thus in disliked courses, college students invest less. Another minor, yet interesting, finding is that the correlations between affective, behavioral, and cognitive regulation across learning contexts were not as high as would be expected if these forms of regulation were traits. More research is needed to unpack whether these forms of regulation are traits and how context influences them.

Limitations and future directions

There are a number of limitations to our study, which limit the types of claims we can make from these data but also highlight several potentially fruitful avenues for future research. First, our study is a single-time, cross-sectional survey administered during the middle of the semester. This type of study design raises several issues with respect to the path models tested. Specifically, Maxwell and Cole (2007) reported that within cross-sectional data, mediational effects are larger than they appear in comparison to longitudinal data. Thus, it is possible that the indirect effects we reported were amplified by our study design. Additionally, we were unable to directly test the causal relations proposed within our framework, since all measures except achievement were assessed simultaneously. Further, our study provides preliminary evidence of possible developmental differences between high school and college students. However, our cross-sectional data do not allow us to explain how, why, and when these differences emerge. Thus, future research should employ longitudinal designs to investigate the interplay among affective, cognitive, and behavioral regulation; self-regulated learning strategies; and achievement.

Such an approach would allow the consideration of reciprocal relations between self-regulation capacities and learning over time and allow a clearer understanding of potentially varying relations based on development. Future research should also consider employing other research designs, such as diary studies. Such an approach would allow a more fine-grained investigation of reciprocal relations among different forms of self-regulation throughout the semester.

Second, we are limited by our reliance on self-report measures, including the use of self-reported achievement for our college sample. Additional forms of data collection, especially mixed method studies, would broaden our understanding of how self-regulation in learning is inter-related. Moving beyond self-reports, the use of task-specific indicators of self-regulation, such as behavioral traces or physiological indicators, would be useful. Other indicators of learning and achievement would also strengthen this line of research, such as more proximal indicators of learning (e.g., performance assessments, unit exams, quizzes).

Third, our study is limited by our operationalization of course preference. We focused on the simple distinction between favorite and least favorite courses and did not consider variations in how course preference functioned based on other aspects, such as the subject domain or the underlying reason for liking or disliking a course. Given the different forms of knowledge across subject domains, future research should investigate whether course preference has differential effects across course subjects – for example (dis)liking math might be different from (dis)liking drama class. Additionally, future research is needed on whether the reason for course preference influences self-regulation in the course. For instance, does self-regulation vary when students dislike a course because they are not interested in the topic versus they dislike the instructor?

Fourth, we made a number of claims regarding the potential role of regulatory depletion to explain our findings. However, regulatory depletion was not assessed in the current research. Including a measure of regulatory depletion in future research would help to clarify potential mechanisms through which affective, behavioral, and cognitive regulation relate to self-regulated learning strategies and achievement.

Conclusion

Our study provides preliminary evidence to support the notion that students who are emotionally aroused, lack planning capabilities, or struggle to focus, may be less effective at applying learning specific strategies. That is, in order for students to successfully self-regulate their course-based learning, they need to be able to regulate basic emotions (e.g., anxiety or excitement), behaviors (e.g., selecting a conducive study environment), and cognitions (focus). Thus, we propose and have provided initial evidence that such affective, behavioral, and cognitive regulatory processes set the stage for more specific learning strategies, and can be thought of as broader from a hierarchical perspective. As such, the current study helps to integrate self-regulatory processes that have been largely studied in isolation by researchers in clinical, cognitive, and educational psychology. Moreover, our results highlight the need to investigate how these self-regulatory processes combine and influence each other to support achievement across development and context.

Acknowledgements The research reported in this manuscript was supported by grants from: American Psychological Association Division 15 Dissertation Research Award; Social Science Research Institute, Duke University; and the Aleane Webb Dissertation Research Fellowship, Duke University. The findings and views reported in this manuscript are the authors' and do not necessarily reflect the views of Duke University or American Psychological Association.

Appendix

Affective (adapted from Gross & John 2003)

Reappraisal:

When I study or work on tasks related to my (least) favorite class…

1) when I want to feel more positive emotion, I change the way I'm thinking about the situation.
2) when I'm faced with a stressful situation, I make myself think about it in a way that helps me stay calm.
3) I control my emotions by changing the way I think about the situation I'm in.
4) when I want to feel more positive emotion (such as joy or amusement), I change what I'm thinking about.
5) when I want to feel less negative emotion (such as sadness or anger), I change what I'm thinking about.

Suppression:

When I study or work on tasks related to my (least) favorite class…

1) I control my emotions by not expressing them.
2) When I am feeling negative emotions, I make sure not to express them.
3) I keep my emotions to myself.

Behavioral

Planning (adapted from Xu 2008 and Pintrich et al. 1991)

1) I set time to work on my tasks for my (least) favorite class ahead of time.
2) I keep track of what remains to be done in my (least) favorite class.
3) I remind myself of the available remaining time for tasks assigned in my (least) favorite class.
4) Throughout the week, I have set times that I dedicate to my academics in my (least) favorite class.
5) I set a plan for how to go about completing my assignments in (least) favorite.
6) Before I begin a task, like writing a paper or answering a question, in (least) favorite, I consider all the different things I need to get done to complete this task.
7) I make lists for work that needs to be accomplished or finished in (least) favorite.

Location (Environmental Regulation) (adapted from Pintrich et al. 1991)

1) I usually study in a place where I can concentrate on my work in (least) favorite.
2) When working on assignments for (least) favorite, I change where I'm studying or working if I'm not getting my work done as I planned.
3) If I feel I can't study well in my current location, I make an active choice to move, change locations, or change something in my study space (like close the blinds).
4) I choose a different location depending on the type of work I'm working on.

5) I work in an area where I know that I can best concentrate and complete my work for (least) favorite class.
6) I go to study at a place where I know the noise level will not disrupt my work.
7) I choose to study in different areas that will be most well-suited or conducive to my studying for (least) favorite.

Cognitive

Focus

1) I have a hard time concentrating in (least) favorite class.
2) I often lose track of what I am thinking about in (least) favorite class.
3) I have difficulty keeping my mind on school-related things in (least) favorite class.
4) During class time I often miss important points because I'm thinking of other things (like daydreaming).

Metacognition (adapted from Pintrich et al. 1991)

1) When studying for (least) favorite I try to determine or figure out which concepts or ideas I don't understand well.
2) When I study for (least) favorite, I set goals for myself in order to direct my activities every time I study.
3) When I become confused about something I'm reading for (least) favorite class, I go back and try to figure it out.
4) If class materials are difficult to understand, I change the way I read or study the material.
5) I ask myself questions to make sure I understand the material I have been studying in (least) favorite.
6) I try to change the way I study in order to fit the class requirements and teacher's teaching style.
7) I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying.

Self-Regulated Learning Strategies

Organization (adapted from Pintrich et al. 1991)

1) When I study for (least) favorite class, I write brief summaries of the main ideas from the readings and the concepts from the lectures.
2) When I study for (least) favorite class, I outline the material or readings to help me organize my thoughts.
3) I make simple charts, diagrams, or tables to help me organize the class material.
4) When I study for (least) favorite class, I go over my notes and make an outline of important concepts or ideas.

Surface Processing (adapted from Pintrich et al. 1991)

1) When I study for (least) favorite, I practice saying the material to myself over and over.

2) When studying for (least) favorite, I read my class notes and the course readings over and over again.
3) I memorize key words to remind me of important concepts or ideas in (least) favorite.

Deeper Processing (adapted from Pintrich et al. 1991)

1) When I study for (least) favorite class, I pull together information from different sources, such as class time (lectures or discussions) or readings.
2) I try to relate or connect ideas in this subject to those in other classes whenever possible.
3) When reading for (least) favorite class, I try to connect or relate the material to what I already know.
4) I try to understand the materials or information in (least) favorite class by making connections between the readings and the ideas or concepts in the lectures.
5) I try to apply or use ideas from class assignments or readings in other class activities such as lecture, discussion, or groupwork.

Behavioral-Cognitive Engagement (Assor et al. 2002)

1) I pay attention and try to follow what the teacher says in (least) favorite class.
2) I come to (least) favorite class unprepared (without completing assigned readings and assignments, etc.). ©
3) I participate in conversations and discussions that take place in (least) favorite class.
4)I often go through the motions in (least) favorite class, but I'm really not paying attention. ©
5) I skip (least) favorite class. ©

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