Assessing Metacognition as a Learning Outcome in a Postsecondary Strategic Learning Course

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Abstract

While metacognition is an important component of the learning process for college students, development of metacognitive knowledge and regulation is particularly important for students with LD and/or ADHD. The researchers used Schraw and Dennison's (1994) *Metacognitive Awareness Inventory* (MAI) to assess first year college students' baseline and follow-up levels of metacognitive awareness during a strategic learning course for students with LD and/or ADHD. Over their first year in college, the students showed significant improvements in a number of metacognitive subprocesses. Several subprocess scores were also found to be positively correlated with GPA. This study's findings can be helpful to practitioners in the postsecondary LD support field. This approach may also be an appropriate way to evaluate the effectiveness of LD support programs when used as part of a broader programmatic review.

Keywords: Metacognition, learning outcomes, learning disability, postsecondary

Students with learning disabilities (LD) and/or Attention Deficit Hyperactivity Disorder (ADHD) have particular learning needs that may place them at risk for academic failure. Indeed, in comparison to peers without LD, they have lower rates of persistence to graduation. According to Radford, Lutz, Wheeless, and Shepherd (2010), data collected from the National Center for Education Statistics (NCES) showed that 50% of 2003-2004 entering students without disabilities completed a bachelor's degree within six years. In contrast, only 28% of students with LD did so. Based on the same NCES data, Hunt-White (2011) notes that only 24% of students with ADHD in that cohort graduated with a bachelor's degree within six years.

Among factors that may account for lower graduation rates for students with LD are oral and written language deficits, executive functioning problems, difficulty in disclosing an LD, and asking for appropriate support (Dadeppo, 2009; Smith, English, & Vasek, 2002). Dadeppo (2009) asserts that students with LD must have adequate self-awareness in order to recognize and articulate their need for accommodations or other support services to appropriate personnel. Students with ADHD also face challenges to college success. Blase et al., (2009) found that students with current diagnoses of ADHD reported more academic, social, and emotional concerns than their peers without ADHD. Norwalk, Norvilitis, and MacLean (2009) found that higher levels of inattentive symptoms in students with ADHD were predictive of poorer study skills and lower levels of academic adjustment and achievement.

Allsopp, Minskoff, and Bolt (2005) emphasize the importance of self-examination and self-awareness for college students with LD and/or ADHD. Similarly, Skinner and Lindstrom (2003) note that understanding their strengths and weaknesses, articulating their disabilities, advocating for themselves, acquiring effective compensatory strategies and learning skills, and developing goal setting and organizational abilities can enhance the likelihood of success for students with

LD. Explicit training in self-advocacy is particularly important in the first year of college as students make the transition from reliance on parental intervention to the need for personal responsibility and self-disclosure (Smith et al., 2002). As students with LD and ADHD enter postsecondary settings in increasing numbers (National Center for Educational Statistics [NCES], 2000), many service providers are looking for ways to support these students. A metacognitive approach may be an effective way to enhance the likelihood of success for students with LD and ADHD

Review of the Literature

Flavell (1976) defined metacognition broadly as "one's knowledge concerning one's own cognitive processes or anything related to them" (p. 232). He also used the term to encompass cognition about other psychological processes such as emotions and motives and the self-monitoring of one's activities (Flavell, 1987). Subsequent researchers have built upon and further developed the concept. Metacognitive knowledge and metacognitive control and regulation are widely accepted as the two major components of metacognition (Pintrich, Wolters, & Baxter, 2000) and efforts have been made to identify specific elements within them. Schraw and Dennison (1994) specify three subprocesses within the knowledge component (declarative, procedural, and conditional knowledge) and five subprocesses within the regulation component (planning, information management strategies, monitoring, debugging, and evaluation).

Metacognitive skills and strategies have been found to be important for critical thinking skills (Ku & Ho, 2010), a key component for academic success in postsecondary study. Studies have shown relationships between metacognition and overall academic success for college students (Hall, Smith, & Chia, 2008; Kincannon, Gleber, & Kim, 1999; Md.Yunis & Ali, 2008; Nietfeld, Cao, & Osborne, 2005; Romainville, 1994; Schleifer & Dull, 2009; Schraw, 1994; Thiede, Anderson, & Therriault, 2003; Uwazurike, 2010; Young & Fry, 2008). Metacognition has also been found to be important to the success of specific subgroups of college students that face unique challenges. For example, metacognitive strategies contributed to improved reading comprehension for English-as-a-foreign-language/English-as-a-second language (EFL/ESL) students (Latawiec, 2010) and the achievement of college students who were in academic difficulty and in danger of being dismissed from the university (Rezvan, Ahmadi, & Avedi, 2006).

Training in metacognition has been found to improve academic performance in college students (Thiede at al., 2003). Kincannon and others (1999) determined that embedding metacognitive instruction within course content can improve student awareness and application of learning strategies and contribute to course mastery. James and Ocpala (2010) found that teaching that incorporated and modeled metacognitive knowledge and strategies resulted in greater involvement and interaction with text. Additionally, Applegate, Quinn, and Applegate (1994) found that reading instruction that involved students in monitoring their reading processes contributed to improved metacognitive awareness. Burchard and Swerdzewski (2009) found significant improvement in metacognitive knowledge and regulation among college students participating in a course that taught learning theories and provided opportunities for applying practical strategies to assignments from other courses. Students with LD who were included in the study made gains similar to those of the students who did not report having any cognitive disabilities.

A number of researchers indicate that metacognition is an underlying factor in and predictor of academic success as defined by grade point average (GPA) in college students with LD (Ruban, 2000; Trainin & Swanson, 2005). In comparing metacognitive strategy use of college students with and without LD, Trainin and Swanson (2005) recognize benefits to high strategy use in both populations, but they indicate that the use of learning strategies is particularly beneficial for students with LD. They also found that students with LD and low strategy use achieved lower GPAs than any other group of students in their study. The researchers concluded that strategy use is essential to college success for students with LD. Similarly, Reis, McGuire, and Neu (2000) found that gifted college students with LD benefitted academically by creating personal plans that were based on a metacognitive understanding of themselves as learners, including a range of compensatory strategies that allowed them to meet course demands. Allsopp et al. (2005) also affirmed the benefits of engaging college students with LD and/or ADHD in metacognitive analysis of their learning and of individualizing strategy instruction to take into account students' unique learning characteristics.

Given its importance to postsecondary success, it is clear that metacognition should be taught explicitly to college students. Uwazurike (2010) recommends using teaching methods that encourage students to apply metacognitive strategies in their efforts to master content. Bembenutty (2009) asserts that students need to accurately assess their knowledge or skill in particular areas, acquire a repertoire of strategies to gain knowledge, and select appropriate strategies for particular academic tasks. He urges educators to support students in becoming self-regulated learners by helping them develop metacognitive skills such as planning, goal setting, and allocating personal and environmental resources. Field, Sarver, and Shaw (2003) state that to be effective, programs for college students with LD must help them acquire critical components of self-determination. Many of these components, such as self-knowledge, reflective thinking, planning and organizing, utilizing effective strategies, and evaluating outcomes, involve metacognition.

Method

Purpose of the Study

The current study was conducted as one part of a broader review of a college support program for students with LD and/or ADHD and was focused on assessing metacognitive growth as one of the intended outcomes of participation in a two-semester sequence of strategic learning courses offered within the program. The authors examined initial and follow-up levels of metacognitive knowledge and regulation in students enrolled in first year credit-bearing (1.5 credits per semester) strategic learning courses. The courses were offered by a fee-based comprehensive learning support program for students with LD and/or ADHD at a small, private, four-year liberal arts-based college in the Northeast. Through one-to-one and small group instruction, the courses guide students in applying metacognitive processing and targeted learning strategies to the other academic courses in which they are enrolled outside the program.

Course objectives related to metacognition include development of students' abilities to define and explain their preferred learning styles, strengths, and challenges; to identify and apply learning strategies that match their learning profiles; to select strategies appropriate to the task; to monitor and evaluate their strategy use; and to plan and direct their learning behaviors to effectively meet task demands. Curriculum includes strategic instruction in time management, planning, organization, study skills, reading, research and essay writing, test-taking, and use of assistive technology. Metacognitive coaching is embedded in all course activities. The researchers explored the following research questions:

1. Did students in the program make gains in metacognitive knowledge and metacognitive regulation during their first year of college?
2. Were higher levels of metacognitive knowledge and regulation related to academic success for these students, as demonstrated by GPA?

Study Participants and Data Collection

Forty-eight of the 180 undergraduate first year students enrolled in the two-semester sequence of learning strategy courses participated in baseline and follow-up assessments of their metacognitive knowledge and regulation. Baseline levels of metacognitive awareness and regulation were measured early in the participants' first semester. The follow-up assessment was conducted at the end of the participants' second semester. There were 28 male (58.3%) and 20 female (41.7%) participants, ranging in age from 18 to 22. Full psychoeducational evaluations, including cognitive and achievement test results, were submitted as part of the admission requirements for the program. All participants had documented LD (23) or ADHD (15) or both (10) and a wide range of Wechsler Adult Intelligence Scale-IV (WAIS-IV) subtest scores, characteristic of students diagnosed with LD and/or ADHD. Participants' cognitive profiles showed typical discrepancies between indices. The mean WAIS-IV Index Standard Scores were Verbal Comprehension, 100.4; Perceptual Reasoning, 95.4; Working Memory, 88.4; and Processing Speed, 92.4.

Measurement Instrument

Metacognition has been studied in a variety of ways. Qualitative studies often use structured interviews that allow researchers to gather interpretive data and explore students' perceptions of their metacognitive abilities and behaviors. Verbal reporting of thought processes during a cognitive task (e.g., think aloud strategy) is also used for qualitative data collection and can provide a window into students' metacognitive processes in real time as opposed to asking them to re-

call past use of metacognitive skills and strategies (Ku & Ho, 2010). A qualitative study employing interviews or a think aloud strategy, however, is better suited for an in-depth examination of a small number of participants (Pintrich et al., 2000). For the present study, the researchers wanted to assess the metacognitive awareness of a larger number of students enrolled in the two semester learning strategies course sequence.

Pintrich et al. (2000) assert that there is no single, perfect tool for measuring metacognition, so researchers and practitioners must choose the instrument that best meets their goals, needs, and context. Since the researchers wanted to assess a variety of specific metacognitive skills taught in a specific learning strategies course, study a substantial number of students, and obtain quantitative data that could be compared with students' grade point averages, they decided to utilize an easily accessible survey that students could complete independently, anonymously, and relatively quickly. Several self-report instruments were considered. *The Executive Process Questionnaire* (Hall, 2005) assesses metacognitive behaviors as well as other aspects of executive functioning such as locus of control. The *Behavior Rating Inventory of Executive Function* ([BRIEF]; Roth, Isquith, & Gioia, 2005) also measures aspects of metacognition within the broader area of executive functioning. The *Motivated Strategies for Learning Questionnaire* (Pintrich, Smith, Garcia, & McKeachie, 1993) includes three motivation scales and nine learning strategies scales that assess cognitive as well as metacognitive strategies. These instruments examined a broad range of characteristics and did not assess metacognitive knowledge and skills with the level of specificity the current study was seeking. In comparison, Schraw and Dennison's (1994) *Metacognitive Awareness Inventory* (MAI) provided a more useful tool to assess baseline and follow-up levels of specific aspects of metacognition that were taught in the learning strategies course. These aspects include the development of metacognitive knowledge; planning and organizing; and the selection, implementation, monitoring, and evaluation of learning strategies.

Schraw & Dennison (1994) performed a factor analysis of the 52-item MAI, which they administered to 197 undergraduate students. Their two-factor solution revealed that factor I was composed of MAI items that relate to Knowledge of Cognition and factor II included items that relate to Regulation of Cognition. The authors measured the average of the inter-item correlations for items included on each factor, to estimate reliability and reported an alpha coefficient of .91 for both factors. The alpha coefficient for all items in the MAI was .95. These high measures of internal consistency are indicators of high reliability for the MAI.

Schraw and Dennison (1994) also assessed the validity of their instrument. They proposed that the MAI would correlate with other empirical indicators of metacognitive awareness, intellectual performance, and metacognitive regulation. Their participants provided estimates of their ability to self-monitor their performance, which is a component of metacognitive awareness. Additionally, they completed four sub-tests from the Nelson-Denny Reading Comprehension test as a measure of intellectual performance. Finally, the participants provided estimates of their confidence in their reading comprehension ability as a measure of metacognitive regulation.

The investigators obtained significant correlations between the Knowledge of Cognition scores from the MAI and the participants' judgments of self-monitoring ability ($r = .31$, $p < .01$), as well as Knowledge of Cognition and reading comprehension performance scores ($r = .26$, $p < .01$). The Regulation of Cognition scores correlated ($r = .21$, $p < .05$) with the participants' confidence ratings for their reading comprehension performance. These findings support the validity of the MAI as a measure of metacognitive awareness.

Pintrich et al. (2000) note that the MAI has external validity since there is a positive correlation between scores on the MAI and students' achievement scores. They also state that it satisfies relevance and utility concerns for use with groups since students have usually had experience with similar response formats and it is easy to administer. Schraw and Dennison (1994) concluded that "the MAI provides a reliable initial test of metacognitive awareness among older students" (p. 472). They also suggest that "using the MAI may be a useful strategy for planning subsequent metacognitive training" (p.472). Additionally, the MAI has been used in previous research on college students with and without LD (Burchard & Swerdzewski, 2009; Kincannon et al., 1999; Young & Fry, 2008). The researchers concluded that the MAI was the most appropriate tool for this study because it allowed them to assess their students' performance in specific areas that are consistent with course objectives, determine those most correlated with academic achievement, and guide future instruction.

The MAI is a 52-item self-report inventory that measures two major components of metacognition: *Knowledge of Cognition and Regulation of Cognition.* The *Knowledge of Cognition* component includes three subprocesses: Declarative Knowledge (self and learning strategy knowledge), Procedural Knowledge (how to use learning strategies), and Conditional Knowledge (when and why to use learning strategies). The *Regulation of Cognition* component includes five subprocesses: Planning (setting learning goals), Information Management Strategies (implementing strategies), Monitoring (paying attention to strategy effectiveness), Debugging (being aware of and correcting errors), and Evaluation (reviewing use of and effectiveness of strategy) (Schraw & Dennison 1994).

Procedure

Baseline data were collected from students enrolled in their first semester in the program. The MAI was transferred to an on-line protocol using Survey Monkey. A link to complete the MAI was sent by email early in the fall to all 180 first-year students who were enrolled in various sections of the learning strategies course. Participants were directed to respond to statements on the MAI by choosing a number on a 10-point Likert-type scale (1 being most false and 10 being most true) that indicated how well a given statement corresponded to their metacognitive knowledge and regulatory behaviors. See Table 2 for sample items. Higher scores indicate higher levels of self-reported metacognitive knowledge and/or metacognitive regulation.

Eighty students responded (44% response rate). In late spring, a new *Survey Monkey* link to the follow-up assessment was emailed to the original 80 participants. Forty-eight (60% response rate) of the original 80 participants responded. The responses from those who completed both the baseline and follow-up were collected via the *Survey Monkey* website and downloaded into spread sheets for subsequent analysis.

Results

The researchers first compared the 48 individual respondents' baseline and follow-up scores on the two major components of the *MAI: Knowledge of Cognition and Regulation of Cognition*. The mean score comparisons are summarized in Table 1.

Changes in the mean scores on the two main components were analyzed using one-tailed, matched pairs, *t*-tests. The baseline mean score for the *Knowledge of Cognition* component was 7.1936 and this value increased to 7.5370 in the spring follow-up. The difference was statistically significant ($t = 1.782$, 47 d.f., $p = .04$). The mean score on the *Regulation of Cognition* component increased from 6.6815 in the baseline administration to 7.0619 in the follow-up assessment. This difference was also statistically significant ($t = 1.893$, 47 d.f., $p = .033$).

A comparison of the mean scores (Table 1) reveals a relatively small difference between the *Knowledge of Cognition* and *Regulation of Cognition* components in both baseline (.51 difference) and follow-up (.47 difference). This is not surprising since a relationship between the two components is assumed in many of the widely accepted theories of metacognition (Brown, 1987; Flavell, 1987). Neither is it unexpected that in both baseline and follow-up, mean scores for *Knowledge of Cognition* are slightly higher than for *Regulation of Cognition*. There is often a gap between knowing about a concept, skill, or process and actually applying that knowledge in practice. Students in this two semester sequence of courses were first-year college students who were in the process of acquiring and applying many of the regulatory skills assessed by the MAI.

In addition to analysis of statistically significant changes in the two major components, a series of one-tailed, matched-pairs, *t*-tests (47 d.f.) were conducted to determine which sub-process scores within the *Knowledge of Cognition* and *Regulation of Cognition* components showed statistically significant changes from baseline to follow-up administrations. All subprocess scores under both components improved. Within the *Knowledge of Cognition* component, only the change in Declarative Knowledge (DK) score, from 7.1016 to 7.5026 ($t = 1.959$, $p = .028$), was statistically significant. However, within the *Regulation of Cognition* component, there were a number of statistically significant increases in sub-process scores. Information Management Strategies (IMS) increased from 6.9313 to 7.2771 ($t = 1.676$, $p = .05$); Comprehension Monitoring (M) improved from 6.381 to 6.9167 ($t = 2.036$, $p = .024$) and Planning (P) increased from 6.5238 to 6.9137 ($t = 1.80$, $p = .039$). The subprocess of Evaluation (E) score increased from 6.184 to 6.6771 ($t = 2.058$, 47, $p = .023$).

Analysis of mean scores for subprocesses within each component provides a closer look at patterns within the global results. Analysis at this level enabled

Table 1

Fall Baseline and Spring Follow-up Comparisons of Component and Subprocess Means

		Baseline	Follow-up
Component Means			
	Knowledge of Cognition	7.19	7.53
	Regulation of Cognition	6.68	7.06
Subprocess of Knowledge of Cognition			
	Declarative Knowledge (DK)	7.10	7.50
	Procedural Knowledge (PK)	7.07	7.41
	Conditional Knowledge (CK)	7.41	7.70
Subprocesses of Regulation of Cognition			
	Planning (P)	6.52	6.91
	Information Management Strategies (IMS)	6.93	7.28
	Comprehension Monitoring (M)	6.38	6.91
	Debugging Strategies (DS)	7.39	7.53
	Evaluating (E)	6.18	6.68

Table 2

MAI Items with the Greatest Improvement Mean Scores

	Statement	Process
17	I am good at remembering information	Declarative Knowledge
34	I find myself pausing regularly to check comprehension	Monitoring Comprehension
42	I read instructions carefully before I begin a task	Planning
43	I ask myself if what I am reading is related to what I already know	Information Management
44	I re-evaluate my assumptions when I get confused	Debugging Strategies
49	I ask myself questions about how well I am doing while I am learning something	Monitoring Comprehension
50	I ask myself if I leaned as much as I could have once I finished a task	Evaluating

the researchers to see changes in students' subprocess scores that occurred over time after direct instruction and through more general experiential opportunities students had as they participated in their first year of college. The students in this study showed significant improvements in the following subprocesses: Declarative Knowledge (DK), Evaluation (E), Information Management Strategies (IMS), Monitoring (M) and Planning (P). It is important to note that the greatest gains were made in subprocesses of the *Regulation of Cognition* (Evaluation, Information Management Strategies, Monitoring and Planning). Though not at the level of statistical significance, gains were shown in all of the other subprocess scores as well.

Analysis of individual items reveals that 50 out of 52 item means increased from baseline to follow-up administrations. Of the seven items showing the greatest gains, all but one (item 17) were within the *Regulation of Cognition* component. Although the *Regulation of Cognition* component score continues to be slightly lower than the *Knowledge of Cognition* component score, the gap between the two is smaller than it was at the beginning of the study. Specifically, students reported the greatest improvement in the items shown in Table 2.

For the spring follow-up administration, item analysis reveals five items in which the mean score is over 8.0. Four of the items are in the *Knowledge of Cognition* component, which continues to be the stronger area. The four items within the *Knowledge of Cognition* component include the following: *I try to use strategies that have worked in the past; I understand my intellectual strengths and weaknesses; I learn best when I know something about the topic; and I learn more when I am interested in the topic.* The one item in the *Regulation of Cognition* component with a mean score over 8.0 is a debugging strategy: *I stop and re-read when I get confused.* In strong contrast to the fall baseline assessment, where there are three item mean scores below 5.75, there were no scores below that threshold in the spring follow-up. The lowest follow-up score of 6.1 is on item 24 (*I summarize what I have learned after I finish*).

The researchers also examined changes in fall baseline and spring follow-up GPAs. The mean GPA for the fall semester was 2.6524 and this value increased to a mean of 2.7904 for the spring semester. The difference was not statistically significant (p = .115, one-tailed), but the increase of .138 average grade points was educationally meaningful. The researchers also sought to determine whether higher levels of metacognitive knowledge and regulation correlated with GPA. The correlations between the *Regulation of Cognition* component score and fall GPA (r = .154) and *Knowledge of Cognition* and fall GPA (r = .237) were not statistically significant. However, for the spring semester, *Knowledge of Cognition* and GPA were more highly correlated (r = .439, p = .003) and the correlation of *Regulation of Cognition* and GPA was statistically significant (r = .371, p = .012). These relationships are consistent with the gains noted in *Knowledge of Cognition* and *Regulation of Cognition* component scores from baseline to follow-up noted above. Specifically, the researchers found a relationship between metacognitive skills and GPA during the spring semester; of particular note is the statistically significant correlation between spring GPA and the scores that measure regulatory behavior.

In addition to the correlations between the MAI component scores (*Knowledge of Cognition* and *Regulation of Cognition*) noted above, correlations between the subprocess scores and GPA for the fall and spring semesters were also examined. Because the subprocess scores are all highly inter-correlated (baseline subprocess score inter-correlations all exceeded r = .625 and follow-up sub-process score inter-correlations all exceeded r = .702) , the researchers used stepwise multiple regression to evaluate each subprocess score's individual contribution to predicting GPA values, independent of the role of other subprocess scores. For the fall semester, Procedural Knowledge (PK) showed a correlation of r = .276, with GPA (p=.03). This finding indicates that variation in PK values accounts for 7.6% of the variation in fall semester GPAs. For the spring semester, the correlation between PK and GPA was r = .486 (p = .001). Thus, variation in spring semester PK scores accounts for 23.6% of the variation in spring GPA. Numerous other subprocess scores were also positively correlated with fall and spring GPA, but their correlation with PK scores made their additional contribution to predicting GPA redundant. The high inter-correlation among all of the subprocess scores suggests that they are all measuring very similar processes of executive function. Controlling for the relationship between PK scores and GPA, further analysis of all the other subprocess scores show insignificant correlations with GPA in both baseline and follow-up.

The increase in mean GPA across the two semesters prompted the researchers to examine changes in the subprocess scores that might correlate with the increase in students' academic performance as measured by GPA. A multiple regression analysis, using the difference between spring and fall GPA scores as the predicted variable, was performed. Results showed that increases in the Planning (P) subprocess score of the *Regulation of Cognition* component were correlated with increases in GPA ($r = .385$, $p = .009$). This finding indicates that increases in Planning account for 14.8% of the variance in the fall to spring GPA score increase. Thus, improvements in planning functions are associated with increases in the students' GPA.

Discussion

The results of this study provide support for including metacognitive knowledge and regulation as targeted outcomes in strategic learning courses aimed at enhancing college success for students with LD and/or ADHD. They also demonstrate a useful and efficient way to assess students' progress in achieving these outcomes. These findings are important to programs and interventions that support first-year college students with LD and/or ADHD as well as college support programs for other populations.

For the first year students with LD and/or ADHD in this study, self-reported levels of metacognitive awareness improved from their first to second semesters in college. Their spring follow-up MAI scores in regulatory behavior were significantly correlated with their GPAs. It is clear that metacognitive awareness can be enhanced and that it is related to college achievement. The fact that these students made gains in metacognitive regulation and that regulation was positively correlated with GPA suggests that college programs for students with LD and/or ADHD should incorporate instruction in metacognition and provide opportunities for students to apply regulatory skills to course work. While a variety of experiences likely contributed to the growth of metacognitive knowledge and regulation in the students in this study, it is also likely that participation in a learning strategies course emphasizing metacognitive growth also contributed to their gains in this area.

The researchers found that the MAI was a useful tool to evaluate students' levels of metacognitive knowledge and regulation. Having information regarding students' general levels of metacognitive knowledge and regulation and their performance on specific subprocesses within these components can allow practitioners to target and evaluate students' growth in these areas. For college LD and/or ADHD support programs, MAI results can be used in conjunction with students' psychoeducational assessments when planning educational interventions. When used to collect pre- and post-intervention data about students enrolled in a learning strategies course, the MAI can measure individual student's growth in metacognitive awareness and contribute to the assessment of the course or program's efficacy. This can make it a valuable part of a multi-faceted, comprehensive program evaluation. In fact, the study reported here was one component of a broader outcomes assessment that included, among other measures, qualitative interviews with students and written student evaluations of the program.

While this study was conducted only with students with LD and/or ADHD, it is likely that interventions that foster metacognitive growth will also contribute to the academic success of other student populations. Many new college students struggle because their past experience and prior knowledge do not sufficiently prepare them to handle the demands of college. Their beliefs and attitudes about learning and themselves as learners, their repertoire of strategies, and their ability to select and apply appropriate strategies may not be conducive to college success. By engaging in metacognitive reflection, they can begin to question, revise, and assess the way they approach academic tasks and acquire more effective approaches necessary for success in postsecondary settings. Self-appraisal and self-management are critical for college success. By assessing their own abilities, gaining a better understanding of what is required by various learning tasks, evaluating the efficacy of their strategies, and acquiring more effective learning skills, students who may have become discouraged and given up can discover ways to help themselves succeed (Taylor, 1999). Metacognitive monitoring and regulation of learning behaviors has the potential to contribute to academic success for postsecondary students who are at risk for a variety of reasons including learning disabilities, emotional challenges, or inadequate preparation.

This study examined relationships between metacognition and academic success in college students, but has implications for other contexts as well. In studying adults with dyslexia, researchers have found

that participants improved their feelings of self-efficacy when they understood their skills and abilities, were able to set goals, and could plan the steps needed to accomplish them. These regulatory behaviors were key contributory factors in participants' reports of increased self-efficacy and were related to success and employment satisfaction in the workplace (Gerber, 2002; Gerber, Ginsberg, & Reiff, 1992; Leather, Henriette, Seiss, & Everatt, 2011; Madaus, Ruban, & McGuire, 2003).

Limitations

The current study was conducted as one part of a broader review of a college support program for students with LD and/or ADHD. The researchers focused on assessing metacognitive growth as one of the intended outcomes of participation in a two-semester sequence of strategic learning courses offered within the program; therefore, the study did not employ a control group. Future research is needed to compare data from students with LD and/or ADHD, not enrolled in learning strategies courses, with those who are. This would allow researchers to better assess the impact of the courses in raising metacognitive awareness of first year college students.

Generalizability of results of this study is limited by the fact that all participants in this relatively small study were enrolled at one private, liberal arts college. Future studies of college students in other settings would be helpful.

It is also important to note that self-report instruments are limited by their dependence on the creditability of the respondents (Paulus & Vazire, 2007). It is recognized that results of self-report inventories such as the MAI should not be used in isolation as a diagnostic tool, but can be a valid and positive addition to the assessment process (Paulus & Vazire, 2007; Roth et al., 2005).

The researchers do not claim that the measured growth in metacognition that occurred in participants was solely the result of participation in the courses. They recognize that there are other developmental and environmental variables that likely contributed to the gains in students' metacognition. For example, instruction in some metacognitive strategies may be incorporated in other courses. Maturation and developmental changes that typically occur as part of emerging adulthood may also contribute to growth in metacognition. Therefore, the researchers do not assert a causal relationship between participation in the courses and the gains in metacognition evidenced by the subjects' MAI scores. They do, however, believe that it is likely that the focus on metacognitive knowledge and regulation in these courses contributed to the students' growth in this area. The researchers also acknowledge that since participants were self-selected volunteers, they are not necessarily representative of all of the students in the LD/ADHD support program.

Conclusion

A number of studies suggest that metacognition is an important factor in college students' achievement and is a tool that can help them to become more effective learners. The literature also suggests that metacognitive instruction is particularly helpful for students with LD and/or ADHD. Embedding metacognitive instruction in college coursework can provide significant opportunities for students in postsecondary settings to make gains in developing academic self-efficacy. Comprehensive learning support programs have a unique opportunity to provide instruction in metacognitive knowledge and regulation in order to support students' growth of self-understanding and mastery of academic tasks. Providing a means to assess whether students are making gains in developing metacognition is critical when this construct is a curricular component. One possible tool to examine both baseline and follow-up levels of metacognitive knowledge and regulation is the MAI.

The researchers believe that an in-depth analysis of the results of the MAI provides important information that can guide effective practice in working with college students with LD and/or ADHD. The use of the MAI as a tool for assessment of metacognitive knowledge and regulation can also inform curricular review and revision in comprehensive postsecondary support programs. In the program studied, commitment to metacognitive growth was reinforced through curricular changes that include linked strategy and subject matter courses in mathematics, history, management, and education. Additionally, e-portfolios have been added to some sections of the course as another means to encourage reflective learning behavior.

While it is not possible to directly link the growth in metacognitive knowledge and metacognitive regulation measured by the MAI to participation in the strategic learning courses, it is likely that strategy

instruction can contribute to gains in self-efficacy for college students with LD and/or ADHD. Additionally, this study showed that higher levels of metacognitive knowledge and regulation were positively correlated with GPA. Postsecondary institutions with comprehensive learning support programs would benefit from incorporating metacognitive instruction into their work with students with LD and/or ADHD.

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