Journal of the Scholarship of Teaching and Learning, Vol. 8, No. 2, May 2008, pp. 1-10.

Metacognitive awareness and academic achievement in college students

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Abstract: The researchers examined the Metacognitive Awareness Inventory (MAI) (Schraw and Dennison,1994) to determine how it relates to broad and single measures of academic achievement in college students. Correlations were found between the MAI and cumulative GPA as well as end of course grades. Scores on the MAI significantly differ between graduate and undergraduate students. Professors' use of the MAI as a potential screening tool to identify students requiring metacognitive strategy intervention is discussed as well as implications for future research.

Keywords: metacognition, metacognitive awareness, GPA, grade.

College professors today are faced with classrooms full of students who come to them with varying levels of knowledge about how they learn. Some students are active, self directed learners who know how they learn and are able to apply what they know to various learning situations. Others may be average students who work hard and who have awareness of their learning strengths and weaknesses, but who may not adequately regulate their learning. Still others may be passive learners who have little awareness of how they learn and how to regulate their learning. In essence, professors are faced with classrooms full of students who come to them with various levels of metacognitive skills.

Metacognition is generally defined as the activity of monitoring and controlling one's cognition. It can further be defined as what we know about our cognitive processes and how we use these processes in order to learn and remember (Ormrod, 2004). Researchers further conceptualize metacognition by breaking down metacognition into two subcomponents, metacognitive knowledge and metacognitive regulation. These two subcomponents have been theorized to be related to one another (Brown, 1987; Flavell, 1987; Schraw and Dennison, 1994).

Metacognitive knowledge can be described as what we know about our own cognitive processes. Declarative, procedural and conditional knowledge may all be considered subcomponents of metacognitive knowledge (Schraw and Moshman, 1995). Declarative knowledge involves what we know about how we learn and what influences how we learn. Procedural knowledge is our knowledge about different learning and memory strategies/procedures that work best for us. Conditional knowledge is the knowledge we have about the conditions under which we can implement various cognitive strategies. As a whole, our knowledge of cognition refers to what we know about how we learn; what we know about the procedures and strategies that are the most effective for us; and, what we know about the conditions under which various cognitive activities are most effective (Schraw and Moshman, 1995).

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Metacognitive regulation in contrast to metacognitive knowledge may be thought of as the actual activities in which we engage in order to facilitate learning and memory (Schraw and Moshman, 1995). Metacognitive regulation can be broken down into three component activities. These include planning, monitoring and evaluating. Planning involves just that, planning out a cognitive task by selecting appropriate strategies and cognitive resources. Monitoring involves the awareness of our progress through a cognitive task and our ability to determine our performance. Finally, evaluating involves taking a look at the outcome and determining if the learning outcome matches our learning goals and if the regulation processes we used were effective (Schraw and Moshman, 1995).

It stands to reason that if students have well developed metacognitive knowledge and metacognitive regulatory skills and they use their metacognition they will excel academically. Consequently, it is important to be able to assess metacognition of college students to determine if this knowledge and skills are related to academic achievement. If we can say that metacognitive knowledge and skills are related to measures of academic success then professors can use various techniques to assess their students' metacognition and develop means by which to improve students' metacognition when necessary.

I. Metacognitive assessment and academic achievement.

Researchers have examined metacognition and how it relates to measures of academic achievement. In these studies metacognitive skills are measured in terms of metacognitive regulation, metacognitive knowledge or both of these components. However, these components are measured differently within the literature. Some researchers use self report inventories to assess metacognitive skills and relate them to achievement measures (Schraw and Dennison, 1994; Sperling et al., 2004). Other researchers examine metacognitive judgments in the form of monitoring accuracy as a measure of metacognitive regulation on various tests (Everson and Tobias, 1998; Nietfeld et al., 2005; Schraw, 1994). Monitoring accuracy is measured in terms of what is considered calibration of performance. Calibration of performance judgments are made at the local and global levels. Local judgments are made after each item on a test. Local monitoring accuracy is determined to be the average difference between the actual answer of each test question and the students' judgment of how well they answered each question. Global judgments are made after the entire test is completed. Students are to judge how well they think they did on the test as a whole. Global monitoring accuracy is determined to be the difference between the overall test score and the students' judgment of how they did on the test. Local monitoring accuracy is thought to be a measure of ongoing metacognitive regulation during testing and global monitoring accuracy is thought to be a measure of cumulative metacognitive regulation (Nietfeld, et al 2005). The following is a brief review of studies utilizing both survey and measures of monitoring accuracy to assess metacognitive knowledge and/or metacognitive regulation.

Everson and Tobias (1998) were interested in knowledge monitoring accuracy. This skill is thought to be involved in metacognitive regulation. They developed a means to assess students' knowledge monitoring ability (KMA) by examining the difference between students' estimates of their knowledge in the verbal domain and their actual knowledge as determined by performance on a standardized verbal test. They found the greatest relationship to be between the KMA and students' end of course grade in English, then the humanities and the students' overall

GPA. They also found that this measure of metacognitive regulation, the KMA, was related to academic achievement in college and it was a good predictor for success in college.

Schraw (1994) was interested in the relationship between metacognitive knowledge and metacognitive regulation. He measured metacognitive knowledge by asking students to rate how well they thought they could monitor their accuracy on a series of multiple choice reading tests. He measured metacognitive regulation at both the local and global levels by having students rate accuracy for each question then rate their accuracy after completing the tests. Based on the results of his study, Schraw suggested that adult students may differ not so much in their metacognitive knowledge skills but in their metacognitive regulation skills. He further suggested that metacognitive knowledge may develop independently of metacognitive regulation. Finally, Schraw found that actual test performance was significantly correlated with judgments of test performance made before testing, a measure of metacognitive knowledge. Test performance was also correlated with metacognitive regulation in that he found correlations between performance and local and global judgments.

Nietfeld et al (2005) examined metacognitive regulation by measuring monitoring accuracy at the local and global level on a series of multiple choice tests given as a part of a semester long course. They found that monitoring accuracy remained stable across tests throughout the semester. They also found that students were more accurate in their global predictions than their local predictions. They found that student performance on the tests was related to local monitoring accuracy.

Schraw and Dennison (1994) developed the Metacognitive Awareness Inventory (MAI) to assess metacognitive knowledge and metacognitive regulation which they referred to as the knowledge of cognition factor and the regulation of cognition factor. The MAI consists of 52 questions tapping into these two components of metacognition. They found that there was strong support for the knowledge of cognition and regulation of cognition components and that these two components were related as had been suggested in the research (Brown, 1987).

Schraw and Dennison (1994) also tested the convergent validity of the MAI by comparing MAI scores with other measures thought to be related to metacognition such as pre-test monitoring ability, actual test performance and the ability to accurately monitor test performance. They did not find a significant relationship with regard to monitoring accuracy and the MAI or between pretest judgments and monitoring accuracy. They found the knowledge of cognition factor of the MAI was related to higher test performance and the regulation of cognition factor of the MAI was not.They also found that knowledge of cognition as measured by pretest judgments was related to the MAI. Pretest judgments were also related positively to test performance.

Sperling et al (2004) utilizing the MAI to determine college student metacognitive awareness, found a significant correlation between the knowledge of cognition factor and the regulation of cognition factor. They also were interested in whether the MAI would be correlated with other measures of academic achievement such as SAT scores and high school average. They found no relation between scores on the MAI and measures of academic achievement. They were surprised to find a negative correlation between SAT math scores and the MAI scores.

Overall, the findings in the research reviewed above regarding the correlation of metacognition with academic and achievement measures indicate that when regulation of cognition is measured by having students estimate their performance on either a local or global

level, regulation of cognition is related to test performance, domain specific GPA scores and overall GPA scores (Everson and Tobias, 1998; Nietfeld et al, 2005; Schraw, 1994).

It appears that when metacognition is assessed through calibration of performance measures there is support for the relationship between metacognitive skills and measures of academic achievement. Unfortunately, determining monitoring ability and monitoring accuracy at the local and global level to assess metacognitive knowledge and regulation skills is a labor intensive endeavor. This situation is especially true for students who are assessed in their actual college classes and not a laboratory or contrived setting. Students monitoring their accuracy on a local and global level must take the time to answer the test questions and then respond to how confident they were about their performance on each question. This process can be a time consuming and possibly stressful task for students while taking tests that will count toward their end of course grades (Nietfeld, 2005). It is important to assess students in a less intrusive manner in order to ascertain their metacognitive awareness and skill level. A less intrusive assessment such as a questionnaire, will allow instructors to quickly identify struggling students early on and assist them in developing effective metacognitive skills.

In a departure from utilizing metacognitive judgments as a method to determine metacognitive skills Schraw and Dennison (1994) developed the MAI as a quick and easy means to assess metacognitive awareness. As reported above they found the MAI correlated with reading comprehension test performance, a measure of academic achievement, only on the knowledge of cognition factor. Sperling et al (2004) did not find a correlation with more comprehensive measures of academic achievement such as SAT scores or high school GPA. Obviously the results of the studies in which the MAI was used to assess metacognition are mixed.

The MAI, needs to be examined further and in a broader context. Instruments used to assess metacognition must be sensitive to comprehensive measures of academic achievement that require a variety of cognitive skills in addition to general verbal ability. Assessments must be easy to administer and score so professors can use the information to help students over the course of a semester. Metacognitive assessments must also be comprehensive assessments of the theorized components of metacognition, namely metacognitive knowledge and metacognitive regulation.

The purpose of the present study was to further examine the relation between metacognition and broad based measures of academic achievement within a natural classroom setting. The MAI was chosen because it is an easy to administer survey for adults, which can be delivered in both face to face and online classes. Additionally, the MAI taps into the two component model of metacognition, metacognitive knowledge and metacognitive regulation cited in the research (Brown, 1987; Schraw and Dennison, 1994). Furthermore, with the MAI researchers can analyze relationships between metacognitive skills and specific academic skills such as scores on classroom tests, reading comprehension tests etc.Researchers can use the MAI to analyze for relationships between metacognitive skills and broader measures of academic achievement such as cumulative GPA, SAT scores and other standardized scores. The final purpose of the study is to add to the body of knowledge regarding the validity of the MAI in terms of the statistical relationship between metacognitive knowledge and regulation; and in terms of the convergent validity of the MAI with measures of academic achievement.

Given the findings thus far regarding the MAI and academic achievement measures the primary goal of this study was exploratory in nature. The researchers were interested in correlations between the MAI and end of course grades; the MAI and cumulative GPA; and the

MAI and single tests within a semester long course. Furthermore, the researchers were interested in whether scores on the MAI would distinguish between experienced and less experienced students as measured by class standing as graduate or undergraduate.

II. **Method.**

A. Participants.

Undergraduate and graduate education students at a small upper level (junior, senior and graduate level) institution located in Southeast Texas were invited to take part in the study. Junior and senior level students in undergraduate teacher education classes in Reading and Human Learning were asked to voluntarily complete the Metacognitive Awareness Inventory (MAI) during summer and fall semesters. Additionally, graduate students in master's education programs taking core classes were asked to voluntarily complete the MAI during summer and fall semesters. The MAI was offered in a total of 15 classes. Two classes were delivered face to face, while the remaining classes were delivered online. The requirements of the fifteen classes from which students were drawn included multiple choice tests, online discussions with specific content criteria, projects and lesson plans.

Students in both face to face and online classes had access to the MAI online through WebCT. They were told they could take the MAI at any point during the semester in which they were enrolled in the participating class. One hundred and seventy eight students completed the MAI. Forty five or 25.3% were graduate students and 133 or 74.7% were undergraduate students. One hundred and fifty eight or 88.8% of the respondents were enrolled in online classes. The remainder was enrolled in face to face classes with access to an online component of the class. See Table 1 for student characteristics.

Table 1. Student Characteristics.

Gender	**Age**	**Level of College Education**	**Credit Hours Taken Semester of Participation**	**GPA**
Male **3.9%**	20-25 yrs **32.8 %**	<2yrs. **1.7%**	3-6 **35%**	4.0-3.5 **46.9%**
Female **96.1%**	26-30 yrs **22.6%**	2yrs. **17.4%**	7-12 **36.3%**	3.49-3.0 **32.8%**
	31-35 yrs **15.3%**	3yrs. **20.8%**	13-18 **17.5%**	2.99-2.5 **15.3%**
	36-40 yrs **5.6%**	>3yrs. **34.3%**	19-21 **2.1%**	2.49-2.0 **5.1%**
	41-45 yrs **14.7%**	Bachelors **22.5%**	>21 **.9%**	
	Over 45 **9.0%**	Masters **3.4%**		

B. Materials.

The MAI (Schraw and Dennison, 1994) with permission of the first author was used to measure students' metacognitive awareness. The MAI consists of 52 statements which students rate as being false or true on a five point likert scale. The two components of metacognition discussed above are represented within the scale, metacognitive knowledge and metacognitive regulation. Within the MAI these are referred to as the knowledge of cognition factor and the regulation of cognition factor. Within the inventory there are 17 questions related to the knowledge of cognition factor for a possible point total of 85.There are 35 questions related to the regulation of cognition factor for a possible point total of 175. The factor scores are calculated by adding the scores on questions related to each of the factors. Higher scores correspond to greater metacognitive knowledge and greater metacognitive regulation. In addition to the knowledge of cognition score and the regulation of cognition score a MAI total score is derived by summing responses to all 52 questions. The instrument was designed for use on adult populations. The MAI was transformed into a web format so it could be completed by students online.

C. Procedure.

In each of the fifteen classes a link to the MAI was set up on WebCT for students to access. Students in face to face classes had an online component to their classes so they too had access to the MAI via WebCT. The letter within the link explained the MAI and the purpose of the study. Students were asked to consent to complete the MAI and to provide their names on the MAI so their end of course grades could be associated with their score on the MAI. Students were not provided incentive in the form of additional points to complete the MAI as this extra credit would skew their end of course grades and confound the results of the study. Consequently, each class had approximately a 50% response rate. Students were told they could complete the MAI at anytime during the semester. The experimenters downloaded the MAI responses only after the end of course grades were submitted to the registrar in order to avoid bias in assigning end of course grades.

III. Results.

A. Correlations between MAI and measures of academic achievement.

For the 178 respondents the mean MAI score was 206.85. The mean score for the knowledge of cognition factor and regulation of cognition factor was 68.69 and 138.16 respectively. See Table 2 for means and standard deviations of the MAI.

Table 2. Means and Standard Deviations of the MAI.

	M	SD
MAI Total	206.85	20.99
Knowledge of Cognition Factor	68.69	7.28
Regulation of Cognition Factor	138.16	14.94

(n=178)

In order to determine if there were relationships between the knowledge of cognition and the regulation of cognition factors, as well as correlations between scores on the MAI and achievement measures of GPA and end of course grades Spearman's Rho, nonparametric correlation analysis was completed. There was a significant correlation between the knowledge of cognition factor and the regulation of cognition factor $r = .73, p<0.01$. See Table 3.

Table 3. Correlations between MAI scores and broad measures of Achievement.

	Course Grade	GPA	MAI Total	Regulation Factor	Knowledge Factor
Grade	1.00	0.36**	0.19*	0.19*	0.20**
GPA	0.36**	1.00	0.23**	0.20*	0.26*
MAI Total	0.19*	0.23**	1.00	0.97**	0.87**
Knowledge Factor	0.20**	0.26**	0.86**	0.73**	1.00
Regulation Factor	0.19*	0.20**	0.97**	1.00	0.73**

** Correlation is significant at the 0.01 level
*Correlation is significant at the 0.05 level

There was a correlation between the total score of the MAI and end of course grades. Breaking this down into the two factors of knowledge of cognition and regulation of cognition a correlation was found between each of these factors and end of course grades. There was a correlation between GPA and the knowledge of cognition factor and also between GPA and regulation of cognition factor. See Table 3. Albeit relatively modest correlations, these results show a relation between both the knowledge of cognition and regulation of cognition factors of the MAI and broad measures of academic achievement.

A subset of 65 students from the current sample was drawn in order to examine whether the MAI would correlate to single tests within semester long courses. Subjects from four undergraduate sections of an online course titled, "Human Learning and its Application to Education" were drawn for this purpose. This sample was chosen from the larger sample as it contained the largest number of students within the sample taking the same course; each section had the same tests; and course delivery was consistent across sections. Three multiple choice tests were given throughout the semester. Multiple choice questions covered course content and required students to know facts and be able to synthesize and apply information. Spearman's Rho nonparametric correlation analysis was completed on the data. There were no significant correlations between test 1 and scores on the MAI; nor were there significant correlations between test 2 and scores on the MAI. There was a correlation between test 3 and the knowledge factor $r= 0.26, p<0.05$ and the regulation factor $r = .27, p<0.05$ of the MAI.

B. MAI scores and individual differences.

The researchers were also interested in whether there were differences in scores on the MAI between more experienced graduate student learners and less experienced undergraduate student learners. Consequently analysis of variance (ANOVA) was performed. The independent variable was whether a student was a graduate or undergraduate student and the dependent variables were the regulation of cognition and knowledge of cognition factor scores. There was not a significant difference between the two groups on the knowledge of cognition factor. There

was a difference between graduates and undergraduates with regard to the regulation of cognition factor $f(1,177) = 4.13$, $p<0.05$. The mean score on the regulation of cognition factor for graduates was 142.04 and 136.85 for undergraduates.

IV. Discussion.

The purpose of the present study was to further explore the MAI and its relationship to broad and single measures of academic achievement. As was expected and found in previous research (Schraw and Dennison, 1994; Sperling et al, 2004) there was a significant correlation between the regulation of cognition factor and the knowledge of cognition factor. Significant correlations were found between the MAI and broad measures of academic achievement. The knowledge of cognition factor of the MAI was correlated with GPA and end of course grades. The same is true for the regulation of cognition factor. These results also provide support for the validity of the MAI as it relates to academic measures.

Within this study significant differences were found between graduate and undergraduate students with regard to their scores on the regulation of cognition factor of the MAI but not the knowledge of cognition factor. This supports the authors' contention that if the MAI is a good measure of academic achievement then it should yield scores that distinguish between more and less experienced students. Graduate and undergraduate students do not differ in relation to knowledge of cognition, they do differ in terms of their regulatory skills. This finding supports that of Schraw (1994) who found that adult learners tend to differ with regard to the use of metacognitive regulatory skills and not so with regard to metacognitive knowledge skills.

The results of the correlations between the MAI and single test scores within a course were unexpected. In the current study, the MAI is better correlated to broad measures of academic achievement such as GPA and end of course grades rather than single measures. It seems there may be other factors that confound the relation between the MAI and single test performance. Single test performance grades may be impacted by many variables other than one's utilization of metacognitive regulation and knowledge skills. These confounding factors may be physical illness, variations in personal motivation, and, potential problems with the technology required for the online class. Broad measures such as GPA and end of course grades which are measures of academic performance over time are much less sensitive to these vagaries of everyday life. This possibility is one that warrants further research to determine how factors other than an individual's metacognitive abilities temper learning as measured by single test scores.

The results of this study are promising. Given the positive correlations between the MAI and end of course grades as well as GPA it can be a tool for professors to use to screen students in need of direct instruction related to metacognition. This may become especially important in large classes as well as online classes where professors have little opportunity to get to know their students on an individual basis. Professors can flag students who obtain low scores on the MAI and then use the MAI as a means to determine what type of metacognitive knowledge and regulatory skills the student reportedly utilizes while learning.

The MAI is set up so professors can complete an item analysis for low scoring students. Each of the 52 items within the MAI is a statement about one's knowledge of learning or the activities one must undertake to regulate learning. For example, "I understand my intellectual strengths and weaknesses." and "I have control over how well I learn." (Schraw and Dennison, 1994, p. 473) are examples of questions related to metacognitive knowledge. "I pace myself

while learning in order to have enough time." and "I set specific goals before I begin a task." (Schraw and Dennison, 1994, p. 473) are examples of questions related to metacognitive regulation. Professors can examine responses to statements like these and specifically pinpoint areas students are reporting weaknesses. Professors can then tailor instructional intervention related to metacognitive knowledge and regulation to meet the needs of individual students. The use of the MAI as a screening tool and a tool to identify specific metacognitive weaknesses merits further research.

V. Future Research.

In the future the goal will be to further examine the relation between the MAI and measures of academic achievement with larger, random samples of students. The intent behind this is to determine if more robust correlations can be obtained when sampling is random and sample sizes are larger. In addition, future research will focus on using the MAI in the applied setting of a classroom to identify and assist students in developing their metacognitive skills. The MAI will be administered to two sections of the same class, one class of students will serve as the control and the other class of students who score low on the MAI will be identified for metacognitive instruction. Analysis will be completed to determine if students with similar MAI scores in the two classes differ on course related achievement measures when the experimental class members with low scores receives metacognitive instruction and the control class members with low scores receives no metacognitive instruction.

VI. Limitations.

Students participating in the study may not be representative of all adult learners as they were primarily education majors. Additionally, students self selected for the study by volunteering to participate. Thus, higher performing students may have been overrepresented in the sample. Finally, associations between various measures within this study may be confounded by additional variables that were not measured such as motivation, students' personal time constraints etc.

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