Metacognitive Strategies of Teaching and Learning

in Introductory Psychology Classes

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Abstract

Metacognitive strategies of teaching and learning were implemented throughout one semester in two Introductory Psychology classes. Performance on exams was used to assess the potential benefits of metacognitive over traditional methods of instruction and learning. Students' awareness of metacognitive processes was evaluated using four questionnaires, and their engagement with metacognitive strategies for learning was correlated with their exam performance. Results showed that exam performance did not improve throughout the semester and was not enhanced by instruction in metacognitive strategies or awareness of these strategies. Several factors may have contributed to these findings, including the particular measure of learning used, students' expectations about the usefulness of metacognitive strategies, their previous experience with metacognitive learning practices, and their understanding of how to apply the strategies learned.

Introduction

The concept of *metacognition* has produced an enormous amount of research and application since Flavell[1] elaborated on this process of "thinking about thinking." According to Flavell, metacognition is knowledge about one' s own cognitive processes, as well as "executive control" over those cognitive processes. Metacognitive knowledge involves *person variables* (knowledge of how humans in general think as well as how a particular individual tends to think or approach problem-solving), *task variables* (knowledge about the nature of specific tasks and what sorts of cognitive demands they incur), and *strategy variables* (knowledge about cognitive and metacognitive approaches to solving different problems, as well as the conditions under which certain strategies are appropriately applied). For nearly three decades psychological and educational research has pursued the objectives of helping students of all ages[1] become better learners and better regulators of their own learning processes. Research has also emphasized the role of the instructor as a model who provides "scaffolding" of successful metacognitive strategies to students so that they can ultimately become more responsible for their own successful learning (e.g., Kuhn & Dean[2]). For example, one widely applied tool developed to help instructors to teach and model metacognitive processes is *Bloom's Taxonomy* (or its revised versions, e.g., Anderson & Krathwohl[3]), which presents a hierarchy of six increasingly complex levels of cognitive processing: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating. Mastery of higher levels of thought (e.g., analysis and evaluation of information) builds on expertise of lower levels (e.g., remembering and understanding). Bloom's Taxonomy is one of a number of models that make it possible for students to learn explicitly about a variety of[2] cognitive and of metacognitive processes, and to engage in specific learning activities that encourage them to distinguish among the different levels of cognitive processes and practice them. A growing array of instructional activities has been developed to help students gain better understanding and control of their own metacognitive processes, to be more reflective as they learn, and to succeed in major educational objectives such as *critical thinking, learning to learn,* and becoming more *autonomous learners.*

The current research employed explicit instruction and use of *metacognitive strategies* as an alternative set of pedagogical methods, and compared them with more standard methods of instruction in two Introductory Psychology classes. The research drew on aspects of Bloom's Taxonomy as well as on three other major models of metacognition.

Flavell's tripartite theoretical framework for metacognition describes *person variables, task variables, and strategy variables*[4]. The model encourages students to consider how each variable affects their own learning processes. For example, in consideration of person variables, a student could consider which kinds of assignments seem particularly difficult and why, what sorts of skills and motivations he or she brings to each task, and what feelings he or she observes about each task as it is undertaken. A student could likewise consider the task variables related to different assignments, such as what kinds of skills and knowledge each task requires, and how sets of task requirements differ. The student could further reflect on the strategies he or she would use to tackle different assignments, and how he or she would plan and structure the work for each kind of task. Finally, the model

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encourages the student to consider how she or he would monitor progress and regulate or adjust the learning strategies to complete various assignments successfully.

Kuhn and Dean[5] have described four theoretical Levels of Epistemological Understanding: *Realist, Absolutist, Multiplist, and Evaluativist*. A reasoner at each level of epistemological understanding uses different cognitive processes to understand and learn. For example, realistic and absolutist reasoning produce judgments based on assumptions about the nature and constancy of external reality. Little metacognitive awareness or exploration is involved, and judgments are considered correct and final. Multiplistic reasoning reflects a greater degree of metacognitive awareness, and a relativistic interpretation of knowledge and truth. Evaluativistic reasoning incorporates a great deal of metacognitive reflection, and recognizes that argument and evidence are strong arbiters of relativistic arguments.

Sternberg's[6] model of *internal executive processes* includes planning, monitoring, and evaluating. This approach argues that learning is enhanced when a student engages in metacognitive processes that keep track of task planning, monitor progress toward task goals, and produce adjustments to the plan as the progress is monitored and evaluated.

In the present study, the four metacognitive theories described above formed the basis of activities designed to help students in two Introductory Psychology classes develop their own metacognitive learning strategies. The activities were intended to encourage students to draw on more conscious access to their own cognitive and metacognitive processes. One major objective of the research was to compare how well students learned using these metacognitive approaches with how well they learned when more conventional approaches to the teaching of introductory psychology were employed. A second objective was to relate students' own perceptions of their use of metacognitive strategies of learning with their actual performance on exams that tested what they had learned in the course.

Method

Participants

Eighty-eight college students, first-year students through seniors, who were enrolled in two sections of Introductory Psychology participated. The sections met at 10:00 or 11:00 on Mondays, Wednesdays, and Fridays. Most students were not psychology majors. Thirty-nine of the participants identified themselves as male, and 49 identified themselves as female.

Testing Materials

Students completed four questionnaire measures at different times throughout the semester when the course was taught (Fall 2008). The *Metacognitive Awareness Inventory*[7] (*MAI*) provides a list of 52 activities that describe how a student might go about learning (e.g., "I am good at organizing information", "I summarize what I have learned after I finish", and "I use different learning strategies depending on the situation"). In the present study, a shorter version of the original measure was used, which included 34 of the original 52 statements. Students answered True of False to each statement, and each student's score was the total number of statements marked True.

Students responded to a modified version of the *General Studies Metacognitive Orientation Scale*[8] *(GSMOS*) one time at the end of the semester. This scale, originally developed for grade school children in China, was modified to use language appropriate to students and the instructor in college classes. The revised version of the *GSMOS* provided 15 statements about the emphasis on metacognitive learning practices in the course (e.g., "The professor encouraged you to think about difficulties in your own learning", "The professor asked you explain how you learn", and "The professor gave ideas to help you think about new ways of learning"). Students rated these statements on a three-point Likert scale (1 = "Never", 2 = "Sometimes", and 3 = "Often). Scores ranged from 15 to 45 and reflected students' awareness that metacognitive strategies for learning had been encouraged in the course.

Students also completed a 15-item questionnaire designed by the researcher to assess their evaluation of the usefulness of 15 specific activities that were incorporated into the course to enhance learning. Some of the learning strategies were metacognitively based (e.g., one-minute reflection papers and test debriefing), whereas other activities were more traditional learning aides (e.g., study guides and PowerPoint slides). Students rated each learning strategy on a 10-point Likert scale (1 = "No Help" to 10 = Great Help). This questionnaire was administered once, at the end of the course.

A fourth questionnaire, also answered once at the end of the course, was another 10-point Likert measure that asked students to rate the usefulness of four different Metacognitive Theories of Learning that had been taught and used throughout the semester. These four theories, Bloom's Taxonomy[9], Flavell's Tripartite Theory[10], Kuhn and Dean's Levels of Epistemological Understanding Theory[11], and Sternberg's Theory of Internal Executive Processes[12], provided a variety of approaches to using metacognitive awareness and strategies to enhance learning. Students rated the theories separately on the 10-point scale ((1 = "No Help" to 10 = Great Help).

Students' exam scores provided the direct measure of learning in the course. An exam was given every two weeks in the course, and a cumulative Final Exam was given during the traditional exam period after classes for the semester ended. Scores on the exams were correlated with students' responses to the metacognitive questionnaires, and performance on the exams by the two different classes was compared periodically, in conjunction with different schedules for the introduction of metacognitive strategies for learning in the two classes.

Procedure

At the beginning of the semester, students in both classes were introduced to the idea that the administration of several questionnaires would be part of their course instruction. Students were advised that their participation was voluntary and that answers to the questionnaires would remain anonymous and confidential, by means of a number coding system. All procedures of the study were approved by the College of Wooster's Human Subjects Research Committee (HSRC).

The *MAI* was administered three times during the 14-week semester: at the beginning of the second week of classes, at the beginning of the seventh week of classes, and at the end of the semester, on the day before classes ended. The *GSMOS* was administered to the students one time at the end of the semester, as were the two questionnaires related to metacognitive theories and practices. After all questionnaire measures had been completed, students were informed that their responses would be used to evaluate the usefulness of the various metacognitive strategies for learning in which they had engaged during the semester.

Instruction involving the four metacognitive theories and 15 metacognitive learning activities included lectures, PowerPoint presentations, class exercises, and homework assignments. Each of the 15 activities described in the questionnaire was employed at least twice during the semester, and most occurred on a regular basis. Students were engaged in several activities each week that reflected the metacognitive theories and exercises that were being presented. The presentation of these metacognitive strategies had a particular timetable, designed to make comparisons between the two class sections in the use of metacognitive strategies and their effect on exam performance. Neither class received metacognitive instruction for the first three weeks of classes. In Week 4, metacognitive instruction and exercises were introduced in the 10:00 section; this instruction did not occur for the 11:00 class until the beginning of Week 9. Subsequently, both classes received further metacognitive instruction and activities, interspersed with more traditional methods of instruction and learning activities. The design of the study permitted both within-group and between-group comparisons of the effects of metacognitive instruction on exam performance at different times throughout the semester.

Results

Performance on Exams

Figure 1 shows the mean exam scores for each of the two classes on each of the seven exams administered during the semester. Table 1 shows the marginal means associated with each independent variable (i.e., the mean score averaged across all seven exams for each class, and the mean score for each exam averaged across both classes). The data in Figure 1 suggest that there were not large differences in the performances of the two classes on any of the seven exams, although the 10:00 class appears to have done somewhat better overall on most of the exams.

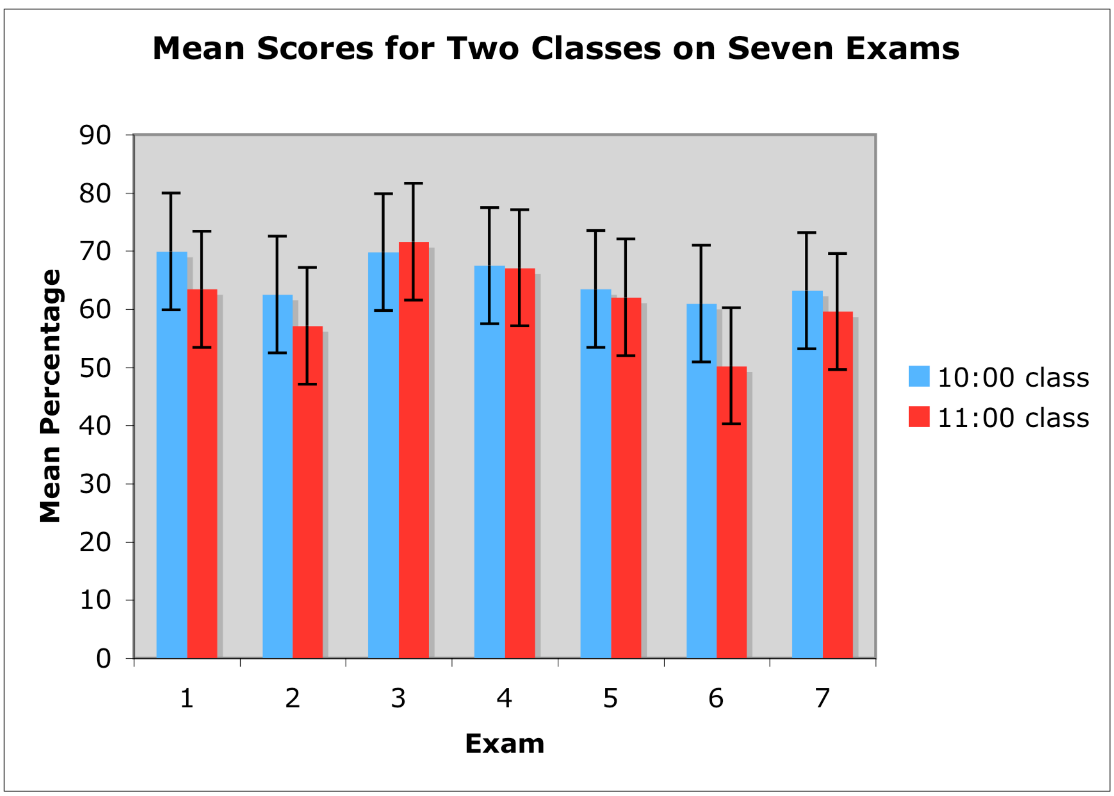

Figure 1. Mean Percentage Scores for two classes on each of seven exams administered to two Introductory Psychology classes in the Fall of 2008. No significant differences emerged between the 10:00 and 11:00 classes on any exam.

The results summarized in Table 1 support this impression, showing that the 10:00 class (*M* = 65.34, S.E. = 1.44) had a higher mean exam score overall than the 11:00 class (*M* = 61.59, S.E. = 1.73).

Table 1. *Mean Percentage Scores for Each Class, Averaged Across All Seven Exams*

Class	Mean	S.E.	n
10:00	65.34	(1.44)	46
11:00	61.59	(1.73)	42
TOTAL	63.46	(1.12)	88

Note: Means for the 10:00 and 11:00 classes did not differ significantly (p > .05).

The results in Table 2 also suggest a number of differences among the seven exam scores (again, averaged across the two classes), although meaningful patterns are hard to discern.

Table 2. *Mean Percentage Scores for Each Exam, Averaged Across Both Classes*

Exam	Class	
	Mean	S.E.
1	67.29[a,]	(1.59)
2	60.32[a,b]	(1.73)
3	70.52[b,c]	(1.49)
4	67.32[b,d]	(1.84)
5	62.90[a,b,c,e]	(1.75)
6	56.59[a,c,d,e]	(2.38)
7	61.74[a,c,d]	(1.24)

Note: Means that share superscripts differed significantly, $p < .05$

To examine statistically the potential differences in exam scores across classes and exams, a 2(class) x 7(exam) mixed model ANOVA was conducted. The ANOVA revealed no significant main effect of Class, $F(1,57) = 2.778$, $p = 0.10$. There was a significant main effect of Exam, $F(1,57) = 19.86$, $p < .001$. The superscripts in Table 1 indicate that there were multiple significant differences among the mean exam scores from Exam 1 to Exam 7 averaged across the two class sections. These differences, although significant, suggest no logical pattern (as suggested above). For example, the mean Exam 3 score (70.52) appears to be higher than other exam scores for the semester; this mean score differed significantly from the scores for Exams 2, 5, 6, and 7, but not from Exams 1 and 4. The mean score for Exam 6 (56.59) appears lower than the other exam scores, and differed significantly from the means for Exams 1, 3, 4, and 5, but not from Exams 2 and 7. The results in Table 1 suggest that mean exam scores fluctuated somewhat across the semester, in similar ways for both classes.

Most pertinent to the experimental hypotheses of the study, the ANOVA showed no significant interaction effect between the variables of class and exam, $F(1,57) = 0.12$, $p = .73$. This statistical finding indicates that the 10:00 and the 11:00 classes did not differ significantly when their mean performances were compared for each of the exams throughout the semester. In this respect the most important comparisons to notice in Figure 1 are between the two class sections for Exam 2 and Exam 4, when metacognitive instruction was first introduced to each class (before Exam 2 for the 10:00 class and before Exam 4 for the 11:00 class). Follow-up independent *t*-tests revealed that for these two exams, the mean performance for the 10:00 class ($M = 62.51$, S.D. = 12.51) on Exam 2, although it appears to be somewhat better than the performance for the 11:00 class (*M* = 57.12, S.D. = 13.81) in Figure 1, was not in fact significantly better, $t(86) = 1.67$, $p = 0.10$. For Exam 4, the *t*-test result confirmed what Figure 1 suggests: that the mean performance for the 10:00 class (*M* = 67.48, S.D. = 13.86) was not significantly different from the mean performance for the 11:00 class (*M* = 67.08, S.D. = 13.86), $t\ (85) = 0.01$, $p = .99$. Therefore, the differential introduction of specific metacognitive instruction at these times during the semester to the two different classes did not produce significantly better exam performance for the class targeted. Two other *t*-test comparisons for the means shown in Figure 1 approached but did not reach statistical significance: the difference between the mean percentage scores for the 10:00 and 11:00 classes on Exam 1 and on Exam 6. In these two cases it appears (in Figure 1) that the mean performance for the 10:00 class was better than for the 11:00 class; but these differences did not reach statistical significance, and were not predicted based on the metacognitive instruction procedures.

Responses to the Metacognitive Awareness Inventory (MAI)

The *MAI* measured the number of metacognitive activities (out of a total of 34) that students reported using to study and learn in the Introductory Psychology class, as assessed on three separate occasions (beginning, middle, and end) during the semester. Table 3 shows the mean number of activities that the students (both classes combined) reported using each time they took the *MAI*. The mean number of activities that students reported using was fairly high (about 23 activities) each time they answered the *MAI*.

A one-way repeated measures ANOVA showed no main effect of time of testing on the number of activities that students reported using, $F\ (1,73) = 2.29$, $p = 0.14$.

Table 3. Responses to the Metacognitive Awareness Inventory (*MAI*) on Three Occasions during the Semester (Two Classes Combined)

Test Occasion	Mean Number of Activities Reported	S.D.	Range	n
MAI-1	22.36	(4.78)	9-33	88
MAI-2	23.58	(5.66)	12-34	86
MAI-3	23.25	(6.65)	0-34	76

To assess the consistency with which students reported using the metacognitive activities, and to evaluate the relationship between the reported use of metacognitive activities listed in the *MAI* and students' actual performance in the course, Pearson's correlations were calculated among the three *MAI* measures and students' percentage scores on the last exam of the semester (Exam 7, the Final Exam). Table 4 shows the results of these correlational tests. As the table shows, use of metacognitive activities, as self-reported by

Table 4. Pearson's Correlations (r) among Final Exam Scores and Three *MAI* Measures

	MAI-1	*MAI-2*	*MAI-3*	Final Exam
MAI-1	1.00	-	-	-
MAI-2	0.77**	1.00	-	-
MAI-3	0.52**	0.70**	1.00	-
Final Exam	-0.11	0.10	0.21 ($p = 0.07$)	1.00

** $p < .001$

the students, showed highly significant positive correlations among the three occasions when the *MAI* was administered. However, Final Exam performance was not significantly correlated with students' reported use of the metacognitive activities listed in the *MAI* on any of the three occasions it was completed (although the relationship between reported use of metacognitive activities for *MAI3* and Final Exam performance approached statistical significance, $r = 0.21$, $p = 0.07$).

Responses to Modified General Studies Metacognitive Orientation Scale (GSMOS)

On the last day of the Introductory Psychology course, students responded to the modified version of the *GSMOS* to indicate how much (on a 3-point rating scale) they thought 15 different metacognitive practices had been emphasized during the course. The mean ratings for these 15 practices are shown in Table 5.

Table 5. Mean Ratings for the Degree of Emphasis on 15 *GSMOS* Metacognitive Practices During the Introductory Psychology Course

Metacognitive Practice	Mean Rating (3-pt scale)
1. Professor emphasized thinking about how you learn.	2.56
2. Professor encouraged you to improve your strategies of learning.	2.77
3. Professor told you how she thinks in her own learning.	2.21
4. Professor asked you to explain how you learn.	1.95
5. Professor encouraged you to try different ways to learn.	2.67
6. Professor told you how class activities could help you learn.	2.65
7. Professor encouraged you to think about difficulties in your learning.	2.42
8. Professor supported you when you tried to improve your learning.	2.47
9. Professor told you how some learning practices might help you learn.	2.68
10. Professor asked you to think about how to study and learn more effectively.	2.68
11. Professor supported you when you tried new ways to learn.	2.44
12. Professor told you how to improve learning with metacognitive strategies.	2.71
13. Professor asked you to try new metacognitive strategies for learning.	2.60
14. Professor encouraged you to talk with each other about learning.	2.18
15. Professor gave ideas to help you think about new ways of learning.	2.63
MEAN TOTAL *GSMOS* SCORE	2.50

According to the mean ratings, the students perceived that almost all of the metacognitive practices were emphasized fairly often in class. Among the 15 practices rated, the two lowest mean ratings were given to "The Professor asked you to talk with each other about learning"

(*M* = 2.18), and "The Professor asked you to explain how you learn" (*M* = 1.95). There were a number of mean ratings above 2.50, suggesting that students were aware of frequent encouragement to use metacognitive practices in the course. The two highest mean ratings were given to the statements "The Professor told you how to improve learning with metacognitive strategies" (*M* = 2.71), and "The Professor encouraged you to improve your strategies of learning" (*M* = 2.77). Overall, the students' estimation of how often metacognitive practices listed in the modified *GSMOS* were emphasized was fairly high, as represented by the Mean Total Rating of 2.50. Nevertheless, when the students' mean total *GSMOS* scores were correlated with their Final Exam scores at the end of the semester, the correlation was not statistically significant, $r = -.15$, $p > 0.05$.

Students' Usefulness Ratings of Four Metacognitive Theories

At the end of the semester, students were asked to rate the usefulness of the four major theories related to metacognition and learning that had been part of class instruction and exercises during the course. These mean ratings (on a scale from 0 to 10) are shown in Table 6.

Table 6. Mean Usefulness Ratings for Four Major Metacognitive Theories (10-pt scale)

Theory	10:00 Class	11:00 Class
Bloom's Taxonomy	6.16	5.36
Flavell's Tripartite Theory	5.39	5.00
Kuhn & Dean's Theory of Epistemological Understanding	4.83	4.65
Sternberg's Theory of Internal Executive Processes	6.97	5.83
MEAN TOTAL USEFULNESS RATING	6.11	5.21
Correlation with Final Exam Scores (*r*)	-0.37*	-0.38*

$p < 0.05$

The mean ratings of the usefulness of the four metacognitive theories suggest that students perceived the theories to have been moderately helpful throughout the semester, with somewhat higher ratings given by the 10:00 class than for the 11:00 class. Despite these ratings of usefulness, there were actually significant negative correlations between Mean Total Usefulness ratings and students' performance on the final exam for both classes, with $r = -0.37$, $p < 0.05$ for the 10:00 class, and $r = -0.38$, $p < 0.05$ for the 11:00 class.

Ratings of Fifteen Specific Learning Strategies

During different class meetings in the Introductory Psychology course, students made use of fifteen specific strategies to enhance learning. These strategies are listed in Table 7, along with mean usefulness ratings (on a 10-point scale) that students made for each strategy at the end of the course. Some of the strategies reflect more conventional methods of instruction (e.g., use of PowerPoint slides, videos, and the textbook's outlines of learning objectives for each chapter), whereas other strategies have a metacognitive emphasis (e.g., use of Concept Maps, One-Minute Reflection Papers, and Test Debriefing). The mean ratings in the table suggest that students perceived some strategies to be more useful than others, and that the 10:00 class often gave moderately higher ratings to the usefulness of the strategies than the 11:00 class gave. Students gave their lowest mean usefulness ratings to One-Minute Reflection Papers, Answer Estimation Exercises (rate how well you think you know an answer, then write the answer, then rate the actual answer) Small-Group Metacognitive Exercises, and Meeting with the T.A. Students gave high mean usefulness to Study Guides they made themselves, Study Guides provided by the professor, PowerPoint slides, and Test Debriefing.

Table 7. Mean Ratings of Fifteen Specific Cognitive Learning Strategies

Strategy	10:00 class	11:00 class
1. Concept Maps	5.85	5.90
2. Study Guides made by self	7.52	7.30
3. Study Guides provided by professor	7.61	7.47
4. One-minute Reflection Papers	4.76	4.30
5. Answer-Estimation Exercises	5.10	4.98
6. PowerPoint Slides	7.68	8.48
7. Small-group - Create Study Questions	6.03	6.04
8. Small-group Metacognitive Exercises	5.06	4.57
9. Video Clips	7.04	7.61
10. One-page Review and Critique of Research	6.50	6.61
11. Test Debriefing	7.13	6.92
12. Use of Text's Learning Objectives	6.44	6.28
13. Meet with T.A.	1.60	0.58
14. Meet with Professor	7.09	5.50
MEAN TOTAL USEFULNESS RATING	6.41	5.18

To assess whether students' ratings about the usefulness of each learning strategy were related to their learning performance, the ratings for each of the 15 strategies were correlated with the students' Final Exam Scores. These correlations are summarized in Table 8, listed for the two classes separately. The Table shows that averaging the ratings for all 15 strategies together produced no significant correlation between the Mean Total Usefulness Ratings and Final Exam scores for the two classes, with the correlations for neither the 10:0 class, $r = -0.18$, $p > 0.05$, nor the 11:00 class, $r = 0.08$, $p > 0.05$, approaching statistical significance. The correlation values that were produced when each of the 15 learning strategies was correlated individually with Final Exam Scores ranged widely from negative correlations to no correlations to positive correlations. But only two of these correlations reached the level of statistical significance: the positive correlation for the 11:00 class between Study Guides – Self and Final Exam Score was significant, $r = 0.35$, $p < 0.05$, as was the positive correlation for the 11:00 class between Study Guides - Professor and Final Exam Scores, $r = 0.35$, $p < 0.05$.

Table 8. Correlations Between Fifteen Specific Cognitive Learning Strategies and Final Exam Scores for Two Classes

Learning Strategy	Correlation (*r*) 10:00 class	11:00 class
1. Concept Maps	-0.05	0.21
2. Study Guides made by self	-0.06	0.35*
3. Study Guides provided by professor	0.08	0.35*
4. One-minute Reflection Papers	-0.14	0.09
5. Answer-Estimation Exercises	-0.28	-0.01
6. PowerPoint Slides	0.07	0.10
7. Small-group - Create Study Questions	-0.22	-0.15
8. Small-group Metacognitive Exercises	-0.23	-0.04
9. Videos Clips	-0.28	0.05
10. One-page Review and Critique of Research	-0.06	-0.08
11. Test Debriefing	-0.19	-0.08
12. Use of Text's Learning Objectives	-0.26	0.07
13. Meet with T.A.	-0.09	-0.12
14. Meet with Professor	-0.05	-0.05
MEAN TOTAL USEFULNESS RATING	-0.18	0.08

* $p < 0.05$

Discussion

Five major findings emerged in the present study about the use of metacognitive teaching and learning strategies in two Introductory Psychology classes:

1.) Performance on exams throughout the semester was not influenced systematically in the two classes by the controlled introduction of metacognitive instruction.

2.) Students reported using a variety of metacognitive practices during the course (measured at three times by the *MAI*). This reported use did not increase during the semester, and was not correlated significantly with Final Exam performance.

3.) At the end of the course, students were highly aware that metacognitive practices had been emphasized and encouraged (revised *GSMOS*). The degree of students' reported awareness, however, was not correlated with their Final Exam performance.

4.) Students rated four major theories of metacognitive processes as being, on average, somewhat useful to their studying and learning. Surprisingly, students' perceptions of the usefulness of these theories were significantly *negatively* correlated with Final Exam performance.

5.) Students provided ratings of the perceived usefulness of 15 specific learning strategies used during the semester. Students rated some strategies as more useful than others, but metacognitive strategies were not perceived to be more useful than more conventional study techniques. Significant positive correlations occurred for one class between the use of Study Guides and Final Exam performance.

The pattern of findings described above suggests that the attempts to teach and encourage the use of metacognitive strategies to learn important content of the Introductory

Psychology class did not connect well with students' actual learning of that content. In addition there appears to be a disconnect between the students' own perceptions about the usefulness and application of the metacognitive strategies and their actual learning of the course content. Several possibilities arise to help us understand why the introduction of metacognitive strategies of teaching and learning did not do more to help students master course content and perform better on exams.

An obvious argument might be that the exams did not test for skills or knowledge that the metacognitive strategies enhanced. Perhaps metacognitive strategies strengthened useful skills of critical thinking that the exams did not evoke, or tested for specific information that was not explored in the metacognitive exercises. This explanation is not likely, because the metacognitive instruction emphasized thinking and learning skills that were important on the exams (e.g., application, analysis, and synthesis), and the metacognitive activities were specifically applied to the material that was tested (e.g., applying Sternberg's *internal executive processes* model to enhance your own study of "type" *versus* "trait" theories of personality). The exams did not merely test for definitions and factual knowledge (although this may have been what some students expected). Given the emphasis on critical analysis and independent learning in the course, it was reasonable to expect that the instruction in metacognitive strategies of learning would improve performance on exams in the course.

Another possibility is that students were not using metacognitive strategies as often or as effectively as they perceived themselves to be doing. If, for example, some students underestimated the amount of effort needed to apply the metacognitive strategies effectively, they might not engage in them consistently or well enough in advance to see the benefits of the strategies in their exam performance. They would thus *perceive* (as measured on an instrument such as the *MAI*) that they were engaging in a fair amount of metacognitive activity, but their perceptions would not be strongly related to their actual exam performance. Since the procedures of this study measured students' reports and perceptions about their metacognitive practices but did not measure the degree of actual use of these practices, one can only speculate about this possible explanation, and note with interest the mismatch between students' estimation of how much they engaged in such practices and their demonstrated learning.

In contrast to the suggestion above, it is possible that students actually reported accurately how much they used various metacognitive strategies for learning, and that these practices were affecting exam performance. Recall that the mean number of metacognitive activities that students reported using (about 23 out of the 34 measured) in their responses to the *MAI* did not change significantly from the beginning of the course (before metacognitive instruction) to the middle (some instruction) to the end (prolonged instruction). Perhaps students came to the Introductory Psychology class with a battery of metacognitive skills that they had previously learned and were already using, even before metacognitive instruction was formally begun in the class. In that case, increases in either the use of metacognitive strategies or exam performance would not be as noticeable as predicted. However, even if students came to the class with some metacognitive skills, one might still expect to see a positive relationship between the degree of use of metacognitive strategies of learning and exam performance across individuals, and this was not the case (although the correlation between *MAI-3* and exam performance approached statistical significance, $r = .21$, $p = 0.07$).

The lack of a strong positive relationship between metacognitive measures and exam performance emerged for the modified *GSMOS* as well: Students were highly aware that metacognitive strategies for learning had been emphasized and encouraged throughout the semester, but their degree of awareness was not related to their Final Exam performance. Students appear not to have benefited from the emphasis they recognized regarding the use of metacognitive practices. Perhaps students were aware of the practices, tried to apply them, and simply got a poor return for their efforts. In that case the results suggest that instructors need to identify better strategies to help students reap the advantages of metacognitive practices. Or, perhaps students recognized the emphasis on metacognitive strategies but did not see the importance or advantage of applying them. In that case instructors should work to identify better strategies to *motivate* students to use metacognitive strategies as they learn.

Even more puzzling than the lack of a strong positive relationship between various metacognitive emphases and exam performance was the significant *negative* correlation obtained between students' ratings of usefulness of the four major metacognitive theories presented in the course and their Final Exam performance. Apparently, the more useful a student found the four theories to be, the worse they performed on the Final Exam. It is possible that time and effort spent learning about the four metacognitive theories detracted from time and effort spent learning the course content, producing the negative correlation. A more likely explanation involves an artifact of the testing procedure. The rating scales for the four metacognitive theories came at the end of a packet of questionnaires given on one of the last days of class. Some students simply skipped this part of the questionnaire packet, and some others marked a usefulness rating of "10" for all of the theories, as though they were marking the questionnaire hastily (and perhaps according to social demand characteristics). It seems likely that some students who rated the theories hastily were also those who did not excel strongly in the class. It is impossible to know this for sure, because the questionnaires were answered anonymously, but lower academic performance paired with rushed, "across-the-board" ratings on the questionnaire could account for the negative correlations. It is odd, however, if this explanation is plausible, that the strength of the spurious negative correlation is almost identical for the two different classes (-0.37 and -0.38 for the 10:00 class and the 11:00 class, respectively).

With respect to the last major finding of the study, pertaining to students' ratings of the usefulness of 15 separate learning strategies presented during the semester, it is somewhat disappointing to observe that the only significant positive correlations found between particular learning strategies and the students' Final Exam performance occurred for the use of Study Guides, either created by the students themselves or provided by the professor of the course. In one way this makes sense, because Study Guides created throughout the semester could be expected to be very useful in preparing for a cumulative final exam. On the other hand, it is surprising that the learning strategies with an explicit metacognitive emphasis were not perceived as being more useful. For the 10:00 class, a number of these metacognitive strategies were somewhat (although not statistically significantly) negatively correlated with exam performance (see Table 8). It is not clear what factors might account for this pattern of correlations. In any case, the broader finding is that the use of particular metacognitive strategies was not strongly correlated with exam performance in the course for either of the two classes.

A growing literature extols the advantages of metacognitive models of teaching and learning. The results of the present study remind us that earnest instruction in these strategies, and even students' expressed appreciation for them, do not automatically lead to better learning. Although test performance is not the only way to measure college students' learning, it is certainly a legitimate way to assess mastery of course content, it is ubiquitously used in college-level education, and it should reasonably be expected to reflect benefits resulting from the use of metacognitive approaches. Further empirical studies can help to sort out what the effects of metacognitive approaches to teaching and learning "ought to be" from what they actually accomplish, and most importantly, *under what circumstances*. The present findings suggest that further research should examine not only the ways we can teach students about metacognitive strategies of learning, but also about ways we can motivate students to use these strategies more effectively.

Notes

1. Flavell, John, "Metacognition and Cognitive Monitoring: A New Area of Cognitive-Developmental Inquiry," *American Psychologist* 34, (1979): 906-911.

2. Kuhn, Deanna , and David Dean, Jr. "Metacognition: A Bridge Between Cognitive Psychology and Educational Practice," *Theory into Practice* 43, (2004): 268-273.

3. Anderson, Lorin, and David Krathwohl, *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives* (New York: Longman Publishers, 2001),10.

4. Flavell, "Metacognition and Cognitive Monitoring," 906.

5. Kuhn and Dean, "Metacognition: A Bridge,"270.

6. Sternberg, Robert, "Inside Intelligence," *American Scientist* 137, (1986): 137-143.

7. Schraw, Gregory, and Dennison, R., "Assessing Metacognitive Awareness," *Contemporary Educational Psychology* 19, (1994): 460-475.

8. Thomas, Gregory, and Au, Doris Kin Mee, "Changing the Learning Environment to Enhance Students' Metacognition in Hong Kong Primary School Classrooms," *Learning Environments Research* 8, (2005): 221-243.

9. Anderson and Krathwohl, "Taxonomy," 20.

10. Flavell, "Metacognition and Cognitive Monitoring," 907.

11. Kuhn and Dean, "Metacognition: A Bridge," 270.

12. Sternberg, "Inside Intelligence," 140.

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