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Abstract

One of the most frustrating teaching dilemmas in post-secondary education is helping students who claim to have mastered the course content but are unable to demonstrate their understanding. These students are often convinced they have a command of the material and may even be able to persuade their instructor that their failure is due to the test. But instructors who carefully question these students realize that most of these students have not mastered the material. This paper will briefly report on research from the last decade on metacognitive knowledge monitoring, and then present a program that teaches both self-regulated learning (SRL) and metacognition. Over the past five years the author has researched the relationship between metacognitive knowledge monitoring (MKM) and classroom learning and has developed a program in his educational psychology class which compels students to regulate their own learning and develops metacognitive skills.

In 1995 a man walked into two Pittsburgh banks in broad daylight with no visible disguise and robbed them. That night the man was caught and was surprised that he had been recognized using surveillance cameras because he was sure that rubbing lemon juice on his face would render him invisible to videotape cameras. In their article "Unskilled and Unaware of It: How Difficulties in Recognizing One's Own Incompetence Leads to Inflated Self-Assessment", Kruger and Dunning (1999) point out that incompetence robs people of the ability to recognize their lack of knowledge or skills which further impedes their ability to succeed. In a variety of studies using different domains such as humor, logic, and grammar, they repeatedly found the least capable people were more likely to significantly overestimate their ability to successfully complete tasks. Their conclusion speaks volumes of the problems teachers regularly address with low achieving students in the classroom. Kruger and Dunning (1999, p. 1123) explain "When people are incompetent in the strategies they adopt to achieve success and satisfaction, they suffer a dual burden: Not only do they reach erroneous conclusions and make unfortunate choices, but their incompetence robs them of the ability to realize it." While we may laugh at the incompetence of the bank robber, we are often frustrated when our students cannot recognize that their strategies for learning are inappropriate and their mastery of their learning falls short of the requirement of the academic tasks. The bank robber and our students share a common deficiency—they have not reflected accurately on their strategies for success.

As students progress through school the demands of the learning tasks gradually increase, with a significant increase in the learning curve as students enter higher education. Some students have been prepared for the challenges of post-secondary education by the requirement of their high school classes. Other students have been given direct instruction in how to study for these new tasks. But many students are not prepared for learning assignments that go beyond the simple memorization of facts or algorithms, and often these students flounder in higher education. Many institutions of higher education are opening their doors to able but poorly prepared students and when these students are faced with academic failure they lack the cognitive or metacognitive skills to modify their learning strategies to overcome these challenges. These students may not be capable of reflecting on their deficiencies.

Adding insult to injury, these failing students actually believe they know the material at the level required of the course and the demands of the task. It is not uncommon to hear these students deny responsibility for their failure: "I knew the material. I was pretty sure I was going to well, and I was positive I'd at least passed the test. It isn't my fault that I failed, it was the test." When university instructors hear these comments they often infer that these students are lying and making excuses—but many of these failing students honestly believed they understood the material. For these students the origin of their problems may be a lack of metacognitive awareness; they cannot assess their knowledge of the task at the level at which they will be evaluated. Motivating these students to learn may not be enough. Teaching these students learning skills may not be enough. The key to assisting these students may depend upon the student's ability to *accurately* assess their level of knowledge. The objective of this paper will be to explore the relationship of knowledge monitoring to academic success in college students and elaborate on a classroom application of self-regulated learning (SRL) and metacognitive knowledge monitoring (MKM) that the author is using in his undergraduate educational psychology course.

Research on Learning

During the past twenty years extensive research (Pintrich, 1995) has explored an area of learning and motivation called self-regulated learning. This research has demonstrated that students' ability to control their behavior, motivation, and cognitive study strategies impacts student's academic success at all levels of schooling. A variety of programs have demonstrated that college students can acquire these learning-to-learn skills and that the mastery of these skills increases success in college (Hoffer, Yu, & Pintrich, 1998; Dembo & Jakubowski, 1999). These programs have proposed that teaching students these learning-to-learn skills will result in increased learning in higher education, but little attention has been paid to exploring the factors that trigger student's adjustments of their learning strategies. To use self-regulated learning effectively a student must know when they need to invoke a new learning strategy. If students believe that they understand the material they are studying, they are unlikely to engage in more extensive use of the strategies they are presently using, much less change their learning strategies. Clearly it is critical for students to know when they know and when they do not know, so they can engage or disengage in learning and adjust their learning strategies when these strategies do not result in mastery of the required material. Two areas of research have explored these questions, calibration and metacognitive knowledge monitoring.

Research on calibration typically focuses on student's ability to estimate their test scores. Classroom research in college settings (Hacker et al., 2000; Isaacson & Fujita, 2001) has illustrated a striking difference between high performing students and low performing students in their ability to predict their test scores: successful students were able to accurately estimate their grades before taking a test, while students who were on the verge of failure were likely to *over*-estimate their future performance. After taking a test but before having it graded, successful students made adjustments in their expectations, further demonstrating their cognitive awareness, while failing students did not realize they had done significantly worse than they had predicted. Successful students have also been found to be able to correctly choose from test questions of varying difficulty while less successful students could not (Isaacson & Fujita, 2002).

Research on metacognitive knowledge monitoring has demonstrated the relationship between academic success and accurate reflection of understanding at both a broad level and in studies which connect metacognitive awareness to self-regulated learning. The Knowledge Monitoring Assessment (KMA) developed by Tobias and Everson (2000, 2002) has shown that learners of all levels of ability and developmental stages including elementary schools, academically oriented high schools, vocational high schools, college freshman and upper level college students, are affected by their ability to monitor their learning. In studies with students of all ages and abilities, Tobias and Everson have found that students who are able to differentiate between when they know and when they do not know are more likely to excel than students who are not able to distinguish their level of comprehension. These studies by Tobias and Everson have focused on the correlation between knowledge monitoring and student's academic performance, but there is very little research on whether metacognitive knowledge monitoring changes over time and whether MKM can be taught. We have begun to explore whether metacognitive knowledge monitoring improves over time (Isaacson and Fujita, 2003) and have found evidence that within a classroom environment in which SRL and MKM are encouraged, student's test scores improve, their calibration scores improve, and they modify their SRL (as measured by the Motivated Strategies for Learning Questionnaire [MSLQ], Pintrich, et al.1991). If self-regulated learning and knowledge monitoring skills improve over time in classroom situations and these skills are critical to academic success, what instructional approaches can be used to facilitate these improvements?

Metacognition has also been shown to impact self-regulated learning. In an experimental study (Thiede, Anderson, and Therriault, 2003) college students who were instructed to reflect on their comprehension of reading text were found to regulate their study behavior more effectively and perform better on subsequent learning tasks than students who were not encouraged to monitor their learning. It was hypothesized that when students are encouraged to focus on the discrepancy between their current state of learning and their desired learning state they are more likely to use self-regulated learning to remove this discrepancy to achieve their goals. The authors proposed that metacognitive monitoring played a critical role in the connection between academic performance and self-regulated learning in a laboratory environment where it is encouraged but, "...it seems likely that left to their own devices people will not accurately monitor comprehension." (p. 71). If students who are instructed to reflect on their understanding in a laboratory environment are more effective in regulating their learning, I began to wonder what I could do in a college course to encourage my students to be more reflective, and whether this metacognitive monitoring could improve their academic performance.

Like many university professors I have experienced the frustration of trying to assist students who claim that they know the material in my course, but they are unable to demonstrate their understanding. I have come to realize that it is not unusual for these students to honestly believe they know the material. After exploring their understanding it is clear that the knowledge of these students is superficial or that they are using the wrong criteria to judge their mastery of the requirements of the course. Over the past decade I have gradually modified my preservice educational psychology class to address many of the challenges faced by these students and their instructors. I believe the heart of the problem for these students revolves around three issues:

- Students' inability to monitor their understanding of the required material at the required level.
- Students' inability to identify appropriate study/learning strategies for the required task.
- Students' tendency to blame failure on external attributions such as the teacher, the test, or the circumstances.

The primary focus of this paper is to share what I have learned about the relationship of metacognitive knowledge monitoring to self-regulated learning and elaborate on class-

room practices that I have developed that reveal and teach this relationship to students. I will explain how I have created a classroom environment which:

- Directs students to reflect on their understanding.
- Teaches students alternative strategies to master the required tasks.
- Encourages students to take responsibility for their success and *self*-regulate their learning.

Teaching Metacognition: A Case Study

I teach two sections of approximately fifty undergraduate teacher education students each semester. The classes are made up of both traditional and non-traditional students who are admitted under a relatively open admissions policy. I use Anita Woolfolk's *Educational Psychology* (9th ed.) and would characterize the content of the class as being fairly traditional but many of the procedures I use to teach the course are fairly unconventional. I designed an extensive web page (http://mypage.iusb.edu/~edp250/) that supports the delivery of a variety of course materials. My web page also serves as one method of assisting students to assess their mastery of the material. Each chapter has a variety of materials to support student learning including:

- A hierarchical outline of the concepts.
- Overheads.
- Graphic organizers and cognitive maps.
- Practice tests.

There is also an additional web-based course manager that is specifically designed for each campus of Indiana University called Oncourse (http://oncourse.iu.edu/) that delivers Metacognitive Practice Tests approximately twenty-four hours before each test. This course manager also collects students' biweekly reflection on the application of the content of the class and what they have learned about their own learning.

The course structure includes:

- Two 75 minute lectures per week.
- One 75 minute peer mentor discussion class per week where students are required to complete a 10-question quiz and a Peer Mentor Study Journal.
- One test each Friday.

Students' final grades are determined by weekly tests, discussion group quizzes, points they earn on the biweekly reflection, a self-assessment paper of their SRL, the points they receive for completing a Peer Mentor Study Journal, and a comprehensive final exam. The course is designed to encourage pre-service teachers to study their own learning, specifically their study skills, self-regulated learning, and metacognitive knowledge monitoring.

Accepting a Performance Orientation and Adjusting to It

As much as I would like to think most of my students have an intrinsic motivation to learn educational psychology, thirty years of teaching have demonstrated to me that some students, often the non-traditional students, are intrinsically motivated. Most students though are predominantly performance oriented (Harackiewicz, Barron, and Elliot, 1998). Many students are receptive to the idea that educational psychology can help them become a better teacher, but the primary motivation of these future teachers is to get a good grade or avoid getting a bad grade. I have structured my class around the premise that if I give them choices that will help them to achieve their grade-goals, I can lead them to the water (SRL) and maybe even entice them to drink it. The research on intrinsic motivation and self-determination (Deci, 1980) indicates that allowing choices increases the possibility of a positive motivational orientation. Choice can also be used to encourage students to adopt new learning strategies.

Since the students who experience the most difficulty in higher education are often traditional students who are young adults, I have found it valuable to give them choices and opportunities to improve over the course of the semester. Based on the work of Clifford (1991) I have incorporated a number of variations of the theory of academic risk taking into the course curriculum. The basic thesis of academic risk taking is that students are more willing to take academic risks such as changing their study strategies when they are allowed to experiment in evaluative situations in which a single negative outcome does not necessarily result in failure in the course. Frequent testing allows me to create options in which students can substitute certain academic tasks for poor test scores. These options include substituting a good quiz score for a poor test score or earning points for completing a semester-long journal and substituting those points for a poor test score. To encourage students to change their study strategies I require that they reflect on both their understanding and the relationship between how they study and their level of learning. The course is designed to elicit and reward both accurate self-reflection (MKM) and the regulation of their own learning (SRL) to fit the particular academic demands of the task. Every facet of the course "holds up a mirror" for students to assess the impact of their study strategies and metacognition on their learning as measured by a test grades. In this way, the facets of the course supports student efforts to improve their SRL and MKM over the course of the semester.

Since students with a performance orientation are motivated primarily by grades, I attempt to create many opportunities for students to improve their grade by regulating their learning (SRL) over the course of the semester. To encourage them to improve their self-awareness of their understanding (MKM) I have created opportunities to reflect on their understanding and their own learning. To entice students to change their study strategies I have developed a testing format that rewards higher level thinking, gives feedback on self-regulated learning, and has a payoff for knowing-when-you-know. To encourage persistence, I have created opportunities for students to replace early-semester failures with improved grades which are the result of improved self-regulation and self-monitoring.

Testing Higher Level Thinking: Variable Difficulty—Variable Weight Objective Tests

Traditional college students are typically resistant to changing the study strategies that resulted in their prior suc-

cess in high school. Perhaps they are thinking: "These strategies were successful before, why change them now?" To encourage students to choose to change their strategies it is important that they are given evaluative tasks that demand higher level thinking skills. Unfortunately, most evaluative tasks which require higher level thinking tend to be open-ended written exercises which take time to grade. Students often see this as being quite subjective. This causes two potential problems when the purpose of the task is to assist students in recognizing the effectiveness, or ineffectiveness, of their study skills. First, students may attribute their lack of success on these tasks to the grading of the teacher: "I really knew the material well, but the teacher doesn't like the way I write." These external attributions undermine the feedback the student receives. Second, the time delay involved in getting feedback to large classes interferes with students reflecting on their learning. To encourage students to choose to change how they study they need to be given a task which requires higher level thinking skills but also gives the student immediate feedback (minutes not days) in an objective manner.

In an effort to motivate students to examine their self-regulated learning I have developed a number of testing formats that:

- Encourage students to study for higher level thinking skills.
- Reward students for demonstrating higher level thinking skills.
- Give students immediate objective feedback.
- Present feedback which allows students to examine the effectiveness of various study strategies such as rehearsal, elaboration, and organization.
- Encourage students to take academic risks.
- Allows students to reduce the negative impact of not knowing as long as they "know when they *don't* know."

The basic premise of the Variable Difficulty—Variable Weight testing format is to present three levels of test questions that theoretically each require a different level of learning and allow students to choose which questions they wish to take. The original Variable Difficulty—Variable Weight test format has been modified a number of times to further encourage students to reflect on their own metacognitive accuracy. The three levels of objective test questions listed below reflect the latest iteration of the variable difficulty—variable weight test.

Many instructors give tests with questions of different value which may encourage students to study for different questions with different study strategies. The unique application of the variable difficulty—variable weight test is that students are allowed to choose questions in a manner that maximizes the impact of metacognitive knowledge monitoring. Over the years I have had a number of alterations of the variable difficulty—variable weight test format to encourage students to reflect on how confident they are in their answer. I have extensive anecdotal evidence from students that being required to think about their level of confidence has actually improved their MKM: empirical evidence is being collected to verify this change. Three variable difficulty—variable weight test formats have been used in the past five years including a 26/36 test format, an original front/back format and a revised front/back format.

The 26/36 test format presents students with 16 Level I (1 point), 16 Level II (2 points), and 4 Level III test questions (3 points) from which they choose 26 questions. In this test format students are encouraged to take higher level test questions but only if they are sure they would get them correct. In the 26/36 test format students could choose all the easiest test questions (i.e., 16 Level I and 10 Level II), but the maximum test score they would achieve would be a C+, even if they answered all 26 questions correctly. To receive the maximum point and earn an A, students had to choose to answer the most difficult questions and answer them correctly. The 26/36 test format was modified for research purposes because we were not sure if students were choosing the right test questions. By that, I mean we were unsure if the 26 questions they were choosing to have graded were anymore likely to be correct than the 10 questions they did not choose. Since we did not know whether they knew the correct answer to the 10 questions they did not answer, we could not evaluate the accuracy of their metacognitive knowledge monitoring.

The original front/back test format gave students 1, 2, and 3 points for Level I, II, and III questions "on the front" of their test (consistent with the 26/36 format), but 2, 3, and 4 points "on the back" of their test with a penalty for guessing of 1, 2, and 3 points for wrong answers. This test format gave a strong incentive for "knowing when you know" but it also rewarded and punished students for risk-taking. This added a confounding variable to the research design and created extreme apprehension for some students. I used this test format for two semesters with some students, typically students with good MKM, loving the format and some students absolutely hating the format. While this format was probably too punitive in relation to metacognition, student test results clearly demonstrated the lack of MKM of some students: Some students were so deficient at MKM that they received test scores *below zero*.

The modified front/back format, which is now being used, presents students with:

- 15 Level I questions from which they are to choose 10 for the front of their answer sheet for 2 points each, and 5 for the back of their answer sheet for 1 point each.
- 15 Level II questions from which they are to choose 10 for the front of their answer sheet for 5 points each, and 5 for the back of their answer sheet for 1 point each.
- 5 Level III questions from which they are to choose 3 for the front of their answer sheet for 6 points each and 2 for the back of their answer sheet worth 1 point each.

This modified front/back test format is effective for a number of reasons. First, it gives students an incentive for improving the MKM because choosing the right answers for "the front" can improve a test score dramatically. Second, it gives the instructors consisting of the professor and peer mentors a way to demonstrate to students that they lack MKM. An instructor can explain to a student: "You got 4 Level II

Table 1
Levels of questions on the variable difficulty—variable weight test.

Level I Questions	Level I Questions are basic objective test questions that require only knowledge and comprehension. Since these questions are very basic and can be answered correctly using simple rehearsal strategies, they are only worth 2 points (or 1 point) for each correct answer.
Level II Questions	Level II Questions are also objective questions but they require the application of psychological concepts to classroom settings. The typical question describes a classroom problem and asks the students to solve the problem using concept from class. These questions are typically more difficult and require elaboration. They are worth 5 points (or 1 point) for each correct answer.
Level III Questions	Level III Questions are also objective questions but they are much more difficult and are designed to measure the student's understanding of the structure of the material being learned. There are a number of formats for Level III questions but the most common are analogy questions and hierarchy questions. Students are encouraged to study for these questions using cognitive organization study skills. These questions are worth 6 points (or 1 point) for each correct answer.

questions correct on the back. If you had put them on the front, you would have improved your score by 16 points." Third, the revision reduces the tendency of students to blame their failure on the test format. For example, students can miss 12 of the 35 test question and still earn a B+ **if** they are able to pick the right 12 questions to put on the back of their answer sheet This is very difficult to do, even for the students that have good MKM.

Both the 26/36 test format and the front/back test formats encourage students to think carefully about which questions they choose to answer. The test formats also encourage students to learn to study for the questions that are worth the most points. This test format encourages a number of important skills and dispositions that are consistent with self-regulated learning in students:

- Students choose which questions they answer. This is a key in developing self-regulated learners.
- Choosing test questions requires that students "know when they know." I have been amazed at how important metacognitive knowledge monitoring is to success on these tests and how deficient many students are in this area. Some students may harbor the "multiple guess" beliefs about multiple choice and true-false tests but the front-back test format challenges students to reflect on whether they are just guessing, making educated guesses, or are sure of their test answers.
- Students are given immediate feedback not only on how many points they received, but also on which type of questions they get correct and incorrect. This eventually leads them to examine how they study and how they might change to improve their score since test questions at 3 levels encourage students to explore how they study: Level I (rehearsal), Level II (elaboration), and Level III (organization). Since many students believe all studying is the same, it is important to demonstrate that different study approaches are effective for different types of test questions.
- Students are asked to keep track of how they devote their study time each week and reflect on the effectiveness of their plan for learning. Those who focus solely on rehearsal can see that effective rehearsal results in improved Level I scores but may not necessarily improve Level II or Level III test scores.
- Students realize that "learning" involves more than just memorization. This may be the most important lesson students learn from the variability difficulty—variable weight test format, but for many students this is the most difficult lesson to learn.

Encouraging Metacognitive Thinking: Pre-Post Questionnaires

As part of the data collection for the research on SRL and MKM, I administer a questionnaire immediately before students take their weekly tests. Before students are given the test they are asked to identify:

- How many hours they have studied.
- What percentage of their time they devoted to rehearsal, elaboration, and organization.
- How many points they believe they will achieve on the test (pre-diction).
- Their satisfaction and pride goals.
- How confident they are of achieving their satisfaction goals.

After they have taken the test, but before it is graded, they are asked how many points they believe they will achieve on the test (post-diction) and how confident they are of achieving their satisfaction goal. To highlight the significance of metacognition, and give the students an incentive to be thoughtful about their metacognitive knowledge monitoring, students are given bonus points for accurately predicting and post-dicting their test scores.

After students complete this part of the questionnaire they take their test and questionnaire to another room, have their test graded, and are asked to complete a number of questions on their reaction to their test. These post-grade questions are part of the research study but are also designed to encourage the students to reflect on their success or failure and their attributions for their results. After identifying their test results as a success or failure they are asked a series of attributional questions which help them to examine whether their test score was

the result of their academic ability, their study efforts, their study strategies, their test taking abilities, or the level of difficulty of the test. This information is not only valuable for research purposes—it also raises attributional questions that can stimulate reflection in students. I believe that to learn metacognitive knowledge monitoring and to contemplate changing their study strategies, students need to consider what factors are having an impact on their learning. Asking students questions about the attributions for their success or failure is the first step in this process.

Teaching SRL beyond declarative knowledge: Reflection and application to student learning

I believe the most powerful way to teach students to be self-regulated learners is to teach them the details of SRL, demonstrate why SRL is effective, and give them an opportunity to practice the application of SRL on relevant, meaningful, graded tasks. In the first third of the semester I teach my educational psychology students fairly extensive information on the declarative knowledge of self-regulated learning. I continue to emphasize the use of SRL throughout the semester by integrating the concepts into chapters on individual differences, behavioral learning theory, cognitive models of learning, motivation, and other topics. In addition to making the declarative knowledge relevant and the organizational structure apparent, I also give students many opportunities to integrate self-regulated learning into their procedural knowledge. After studying and taking a test on the declarative knowledge of SRL, students are given an assignment which requires them to write an extensive self-assessment paper of their own study skills in college. This assignment requires that they reflect on their own strengths and weaknesses, including data from the Learning and Study Strategies Inventory (LASSI, Weinstein, 1986) and the integration of the information they have collected from a structured Peer Mentor Study Journal that is part of the peer mentor discussion groups.

My recent work on calibration (Isaacson and Fujita, 2001), the research by Tobias and Everson (2000), and extensive anecdotal evidence has led me to explore the significance of metacognitive awareness in self-regulated learning and to encourage my students to be more reflective. A quote by Winne and Perry (2000, p. 540) describes my present position, "Metacognitive monitoring is the gateway to self-regulating one's learning because without the cognitive evaluation it creates, there is no standard against which to enact regulation." In the past three years I have attempted to encourage my students to be more reflective about their metacognitive awareness and their study skills.

For more than a decade I have used discussion groups led by peer mentors in my educational psychology class. Many of my students had difficulty with higher level thinking questions and when I began teaching students self-regulated learning I found that the peer mentors (undergraduate students who had done well in the class in previous semesters) were the best role models for learning these skills. When it became clear that metacognitive knowledge monitoring was an important part of the change process, I began to integrate a number of curriculum support materials into the program.

Peer Mentor Study Journals

As mentioned earlier, I have found that traditional students are typically driven by evaluation and if there is no "payoff" for being reflective it is unlikely that traditional students will think about their thinking. To facilitate metacognitive awareness in my students I have developed a very structured study journal that requires students to keep track of their study time and place (i.e., SR of Behavior), how they improve their motivation and reduce their test anxiety (i.e., SR of Motivation and Affect), the types of study strategies they use (i.e., SR of Cognitive Strategies), and their reactions to their weekly quiz and tests. In addition I have written a structured set of questions to guide their reflection each week including questions on study strategies, knowledge monitoring before tests, choosing test questions, attributions, and other factors. These guided journal entries are written to reflect the weekly concepts the students are studying in class and to highlight the integration of SRL into learning theory and motivation. Students earn points each week on their journal entries to increase their engagement in the task and the total points earned for the journal can be substituted for one test grade.

Peer Mentor Group Quizzes

Most students volunteer to participate in the peer mentor discussion group primarily because students can earn points which they can substitute for test grades. Each week the peer mentors administer a short quiz to the students at the beginning of the discussion group. The quizzes also use a variable difficulty—variable weight with students identifying 6 of the 10 questions (6 Level I, 3 Level II, and 1 Level III) in which they are more confident. Each quiz is worth 20 points and the five best quiz scores can be substituted for another test score. In the discussion groups the students receive immediate feedback on their quizzes and the format of the quiz elicits metacognitive feedback. Students answer all 10 questions but choose 6 to have scored "on-the-front" (worth 2, 3, and 5 points) with the other 4 questions worth only 1 point. The peer mentors discuss the process of choosing quiz questions emphasizing metacognitive knowledge monitoring.

Confidence Rating: Absolutely Sure, Fairly Sure, and Just Guessing

A number of years ago one of the peer mentors came upon a strategy to help students choose test questions that has become an integral part of our program. Students were having trouble identifying which questions they should put "on-the-front" of their quizzes and tests. The students needed a way to categorize test questions so that they could keep track of how confident they were of their answers. The peer mentor suggested to the students that, as they were taking the test, they label each question as: Absolutely Sure of their Answer; Fairly Sure of their Answer; or, Unsure or Just Guessing at their Answer. The students in her group found this

strategy to be very helpful in categorizing their confidence about their answers. We have since adapted this confidence assessment as part of the data collection in our study and have strong anecdotal evidence that asking this question ("Are you absolutely sure, fairly sure, or just guessing at your answer for this question?) has an impact on students' metacognitive knowledge monitoring. From the comments students have made on their reflection, it seems that many students had never considered how confident they were about the answers they were putting on their tests. By the end of the semester many students have shared with me that not only do they ask themselves this question on all their tests (even tests in other classes), they also have adopted this question while they are learning. While only anecdotal, this indicates to me that encouraging students to reflect on their level of mastery of knowledge and skills should be an important part of the learning cycle for all students.

Bi-Weekly Reflection

In response to NCATE and the INTASC standards, the School of Education at Indiana University South Bend has placed an increasing emphasis on encouraging our teacher education candidates to become reflective practitioners. Recently I have added a course assignment which requires on-line reflections of how students will apply what they are learning in my educational psychology class to their future classroom teaching. I have also added bi-weekly reflections on their own learning with a particular emphasis on self-regulated learning and metacognitive knowledge monitoring. I believe that by consistently raising questions about self-regulation and metacognition I have heightened my students' awareness of these learning issues. The anecdotal responses I have received from students leads me to believe that their first reaction is annoyance, but by the end of the semester most students believe MKM and SRL has improved their learning and they plan on integrating these skills into their own teaching. I have detailed student reflections indicating that many students believe that the course resources such as the test format, journals, confidence ratings, and so on, as well as the bi-weekly reflections have had a positive impact on their MKM, their SRL, and their learning. This qualitative research data is IRB approved and ready for analysis if a colleague were interested in working with me to further explore the SRL, MKM, learning relationship.

Metacognitive Practice Tests

The research by Tobias and Everson (2000) clearly demonstrates that metacognitive knowledge monitoring is closely tied to academic achievement. Their research shows that there is a significant correlation between metacognitive awareness and achievement for students of all ages at every ability level. I have modified the test format, the Peer Mentor Study Journal, the quizzes, and the bi-weekly reflections to try to emphasize to students the importance of reflecting on the degree to which they have mastered the material they are studying. I have also incorporated the confidence ratings (Absolutely sure; Fairly sure; or Just Guessing) of their quiz answer. But many students need assistance with tasks that will give them feedback outside of class on their level of master and their confidence in relation to their MKM. I have recently introduced a new format for the on-line metacognitive practice test that asks students to make this judgement for every practice test question they take every week. Using a web-based course manager, I have delivered a variable difficulty practice test approximately twenty-four hours before their actual test. The students are allowed to take the practice test up to three times using random question selection generated by the software before taking their test. I hope to examine the uses of this practice test to determine which students choose to take advantage of this metacognitive assistant, and eventually to modify the software to allow students to control the level of difficulty of the questions. This software may help us to explore how students decide that they understand the material well enough to disengage from learning before a test.

What have we learned, Where should we go?

While the empirical evidence is not abundant, the anecdotal evidence from my students is clear: students do change their metacognition from the beginning of a semester to the end of a semester *if* there is the support and incentive within the course for them to make SRL and MKM changes. The study by Isaacson and Fujita (2003) demonstrates a relationship between improved test scores, calibration, and expected changes in self-regulation. The student reflections attributes those changes to the resources available in the class and the demands created by the test format of the class. Further research needs to explore this relationship from a number of different perspectives.

The study by Isaacson and Fujita (2003) demonstrates a relationship between metacognition, self-regulation, and learning. The cause-effect of this relationship is critical to pedagogue but the cause is not clear. Kruger and Dunning (1999) suggest that improvements in expertise make improvements in metacognition possible: they contend that the cause is improved learning and the effect is improved metacognition. But student reflections from my class indicate that when students begin to think more about whether they truly understand the content they are studying they are more likely to change their study strategies which leads to increased learning. I have extensive anecdotal evidence (qualitative data) which supports this relationship and I would like to invite interested colleagues to join me in analyzing this data. I have also increased the power of the data I am collecting to allow us to do finer-grain analysis of the longitudinal data on students. A potential research question might be 'Which comes first: changes in metacognition, changes in self-regulation, or changes in test scores?

The question of the relationship of metacognition, self-regulation, and learning in post-secondary students raises a number of other questions that are pertinent to instructors of adolescents and adults:

- What specific classroom practices assist students in assessing their metacognition and monitoring skills?
- What resources can instructors make available to students to help them improve their metacognition?

- Are some students more likely to benefit from these practices and resources, and what can instructors do to create a classroom environment that makes students aware of the need to change?

One of the most challenging aspects of teaching metacognitive knowledge monitoring and self-regulated learning is that the students who are most deficient in MKM and SRL are the least likely to recognize their inadequacy. Students with poor study skills are unaware of alternative approaches to learning and less likely to realize their study strategies are the cause of their poor results. Even more problematic is that they do not even recognize that they are not learning at the necessary level of mastery which leads them to externalize the blame for their academic failure. Over the past decade I have implemented many strategies and course modifications to help students realize their SRL and MKM deficiencies. Each of the strategies mentioned in this paper have been adapted to increase self-awareness of learning in post-secondary students, and I have anecdotal and/or empirical evidence for the efficacy of all of them. But there are still some students whom I have not been able to reach—students for whom a gentle nudge and a "Maybe you don't know this as well as you think." is not enough.

Recently I was introduced to a new technology that I am presently testing in my class to see if it can be used to reach even the students who are most adamant and resistant to considering that they do not know when they don't know. An audience response system (The Hyper-Interactive Teaching Technology or H-ITT) with the appropriate software and hardware allows me to include all students in classroom discussions where each student has an opportunity to anonymously respond to classroom questions and then discuss them with classmates before responding to the questions a second time. By presenting students with challenging questions and pairing them up with study partners in class, I give them the opportunity to reflect on their own understanding in an environment which creates disequilibrium but lessens the embarrassment of the teacher telling the student they are wrong in front of the entire class. I have just begun using the H-ITT technology and look forward to adapting it to my class to improve the metacognitive knowledge monitoring of my students. The possible application of pedagogical adaptations using technology creates new methods of assisting students to improve their metacognition, their self-regulation, and their learning.

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