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ABSTRACT

Metacognition, literally thinking about thinking, is a term used by cognitive psychologists to refer to our ability to monitor our own performance on cognitive tasks. The term also addresses the ability to assess level of knowledge and skill in a given domain. Behavioral and psychological researchers frequently solicit metacognitive judgments from research participants in the form of self-assessment survey items. However, evidence suggests that metacognitive judgments are often at odds with reality. The term metacognitive miscalibration is used to refer to this disparity between self-assessments and more objective measures of ability and performance. The authors have theorized a relationship between metacognitive miscalibration and underachievement in courses where many students enter the class believing they already know the material. This paper reports preliminary results from an ongoing study seeking to understand the relationship between metacognitive miscalibration and underachievement in a computer literacy course. Five figures include pretest quiz results, miscalibration and recalibration in the pretest, comparison of pretest and posttest quiz scores, comparison of improvement by recalibration group, and posttest quiz results. (Author)

METACOGNITIVE MISCALIBRATION AND UNDERACHIEVEMENT IN A COMPUTER LITERACY COURSE: SOME PRELIMINARY OBSERVATIONS

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ABSTRACT

Metacognition, literally thinking about thinking, is a term used by cognitive psychologists to refer to our ability to monitor our own performance on cognitive tasks. The term also addresses the ability to assess our level of knowledge and skill in a given domain. Behavioral and psychological researchers frequently solicit metacognitive judgments from research participants in the form of self-assessment survey items. However, evidence suggests that our metacognitive judgments are often at odds with reality. The term metacognitive miscalibration is used to refer to this disparity between self-assessments and more objective measures of ability and performance. The authors have theorized a relationship between metacognitive miscalibration and underachievement in courses where many students enter the class believing they already know the material. This paper reports preliminary results from an ongoing study seeking to understand the relationship between metacognitive miscalibration and underachivement in a computer literacy course.

INTRODUCTION

"Professor Smith, I want to talk to you about my exam. I'm really surprised at my grade. I mean, I come to class everyday. I really know this material. I took computers in high school. And I felt really good about the exam. I just don't understand how I could have gotten such a low grade. Is there any chance there was some kind of mixup in the grading or something? I just know I didn't fail that test."

What causes students to maintain such a high opinion of their performance in the face of overwhelming evidence to the contrary? Is it possible that this phenomenon in some way impairs the student's ability to learn? If so, might it be possible to correct the student's misconceptions and, thereby, improve learning?

These questions form the basis of an ongoing research project, originally proposed in Smith and Foltz (2000), examining the relationship between metacognitive miscalibration and underachivement. The goals of this research are to develop an instrument that will identify students who are highly miscalibrated, examine the relationship between miscalibration and course performance, search for ways to recalibrate students' metacognitions, and, finally, determine whether recalibration improves course performance.

METACOGNITIVE MISCALIBRATION

Metacognition is not to be confused with affect. Some early reviews of this work suggested including studies of students' attitudes toward computers in the literature review. While affect may influence metacognition, whether students like computers or feel good about using computers, the subject of many MIS educational studies not cited here, is not the subject of this research.

Metacognition, literally thinking about thinking, is a term used by cognitive psychologists to refer to our ability to monitor our own performance on cognitive tasks. The term also addresses the ability to assess our level of knowledge and skill in a given domain. Behavioral and psychological researchers frequently solicit metacognitive judgments from research participants in the form of self-assessment survey items. However, evidence suggests that our metacognitive judgments are often at odds with reality (Kruger & Dunning, 1999). The term metacognitive miscalibration is used to refer to this disparity between self-assessments and more objective measures of ability and performance.

Psychological researchers have several theories to explain metacognitive miscalibraton. At the cognitive level, the cue familiarity theory (Metcalfe et al., 1993) essentially restates the old cliché, "a little knowledge is a dangerous thing." When people have some knowledge of the domain in question, they are likely to have higher metacognitive judgments than when they have no knowledge of the domain. At the social level, the above average effect (Dunning et al., 1989; Alicke et al., 1995) simply says that people have higher opinions of themselves than of others. These self-serving assessments tend to increase with the ambiguity of the trait being assessed (Dunning et al., 1989) and the level of abstraction in the comparison (Alicke et al., 1995).

Regardless of the source of metacognitive miscalibration, psychological and educational researchers have related degree of miscalibration to both prediction of performance on multiple-choice exams (Sinkavich, 1995) and actual exam performance (Shaughnessy, 1979). There seems to be general agreement that competence begets more accurate metacognitions (Maki et al., 1994; Kruger & Dunning, 1999; Shaughnessy, 1979; Sinkavich, 1995). One study suggests that gaining competence in the domain is the only way to correct metacognitive miscalibration (Kruger & Dunning, 1999).

Of more practical concern is research suggesting that metacognitive judgments influence decisions to continue work on a problem (Metcalfe, 1998) and studying (Bjork, 1996). This being the case, improving metacognitive judgments – metacognitive recalibration – should produce better results in courses where students are highly miscalibrated. However, if Kruger and Dunning are correct in their assertion that only domain competence will result in recalibration, then we are at an impasse.

RESEARCH METHOD

A 50-item multiple-choice quiz was developed as a comprehensive test of course knowledge. Questions covered eleven subject areas, with no fewer than four and no more than six items in each area. Of the five possible responses for each item, the last was "I don't know," and the remaining four did not include any obviously incorrect choices. (For example, when asked who is credited with designing the first computer mouse, Walt Disney would be considered an obviously incorrect choice.) Four metacognitive instruments were developed, soliciting students' self-assessments of their course knowledge relative to their peers.

Participants were students enrolled in two summer sections of a computer literacy course, taught by the same faculty member. A total of 33 students completed the course pretest; 23 completed the posttest. The course pretest, administered on the first day of class, consisted of the first metacognitive instrument, followed by the multiple-choice quiz, followed by the second metacognitive instrument. The course posttest, administered on the last day of class, prior to the final exam, consisted of the third metacognitive instrument, followed by the multiple-choice quiz, followed by the fourth metacognitive instrument. Students were instructed to choose the "don't know" response if they were unsure of an answer on the multiple-choice quiz. Students were not compensated in any way for participation and were not informed of either their individual performance or the aggregate class performance on the quiz.

RESULTS

Following the pretest, the multiple-choice quiz was scored and number of correct, incorrect, and don't know responses recorded for each participant. The mean and standard deviation of correct responses was used to construct five groups of students: far below average, below average, average, above average, and far above average. These groups correspond to response options on the metacognitive instruments. The range of correct responses labeled as average was defined as one standard deviation, centered on the mean. Above average was defined as the 1.5 standard deviations beyond average; far above average as the final two standard deviations. Below average and far below average were similarly defined. However, due to the low mean value and the large standard deviation, there were no observations in the far below average group. There was only one observation in the far above average group; this was discarded as an outlier. This left seven students in the below average group, eleven in the average group, and four in the above average group. Figure 1 shows the mean number of correct, incorrect, and don't know responses in each of the three pretest groups.

Item two on the first metacognitive instrument asked participants to rate their "knowledge of concepts and skills to be covered in the course," relative to their classmates.

Response options were far below average, below average, average, above average, and far above average. The corresponding item on the second metacognitive instrument asked participants to rate "overall performance on the pretest," again relative to their classmates. Figure 2 shows the nominal line representing perfect calibration and the mean response for each pretest group on both the first and second metacognitive instruments. The distance between the nominal line and the actual mean represents the magnitude of miscalibration for the group. The average and above average groups were well calibrated, though their self-assessments were somewhat below their actual performance. As anticipated the below average group overestimated their performance, though not to the degree expected.

FIGURE 1
PRETEST QUIZ RESULTS
n = 22

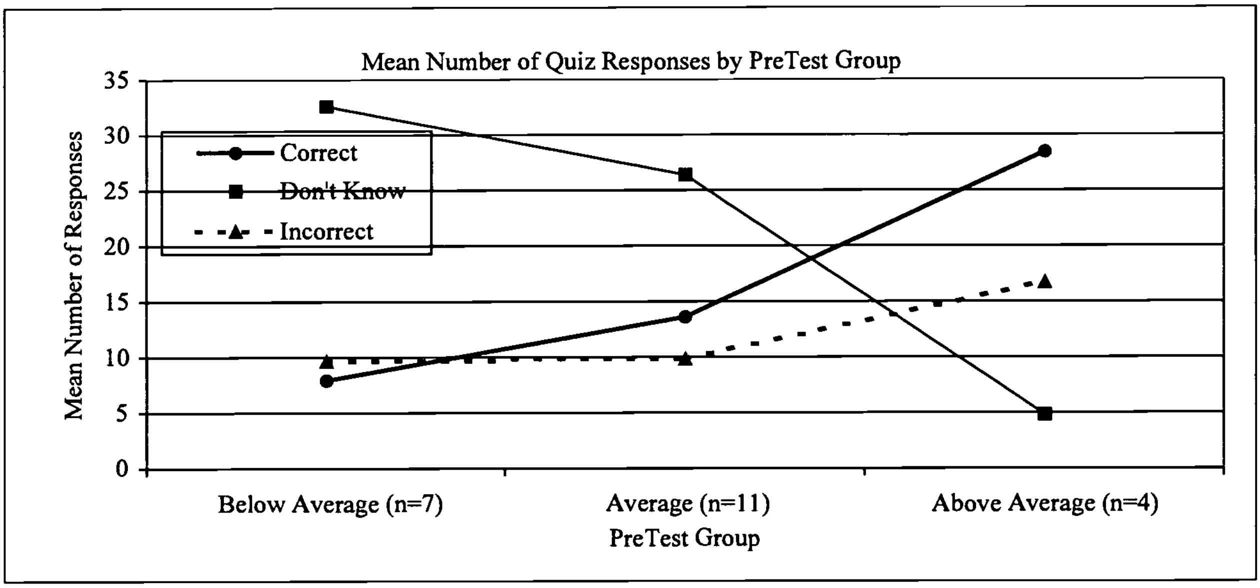
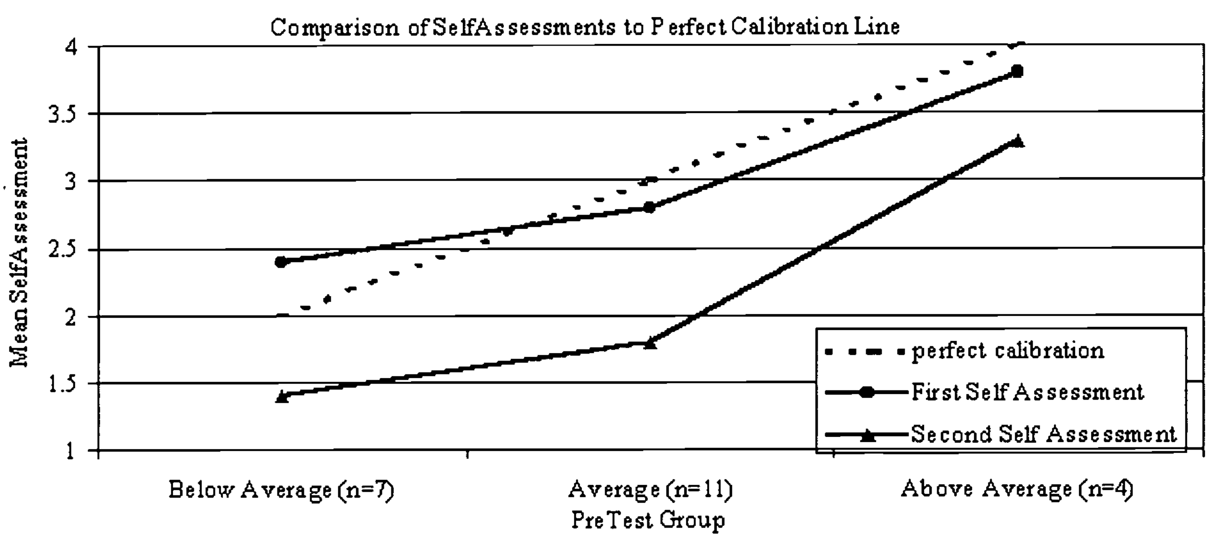


FIGURE 2
MISCALIBRATION AND RECALIBRATION IN THE PRETEST
n=22



At the end of the term, the posttest was administered and scores again plotted by pretest group. Overall, the class improved their quiz scores by an average of twelve questions; the range was two to twenty. As illustrated in Figure 3, though all groups improved their quiz scores, the below average group showed the greatest overall improvement, an average of fifteen questions.

What we had hoped to see, of course, was a difference in improvement between those who recalibrated on the pretest and those who did not. Figure 4 shows mean pretest, posttest, and improvement scores, based on correct responses to the quiz, grouped by whether recalibration occurred during the pretest. Those who recalibrated on the pretest had lower pretest scores, on average, than did those who failed to recalibrate. However, by the end of the course, there is virtually no difference in quiz scores between the two groups.

FIGURE 3
COMPARISON OF PRETEST AND POSTTEST QUIZ SCORES
n=22

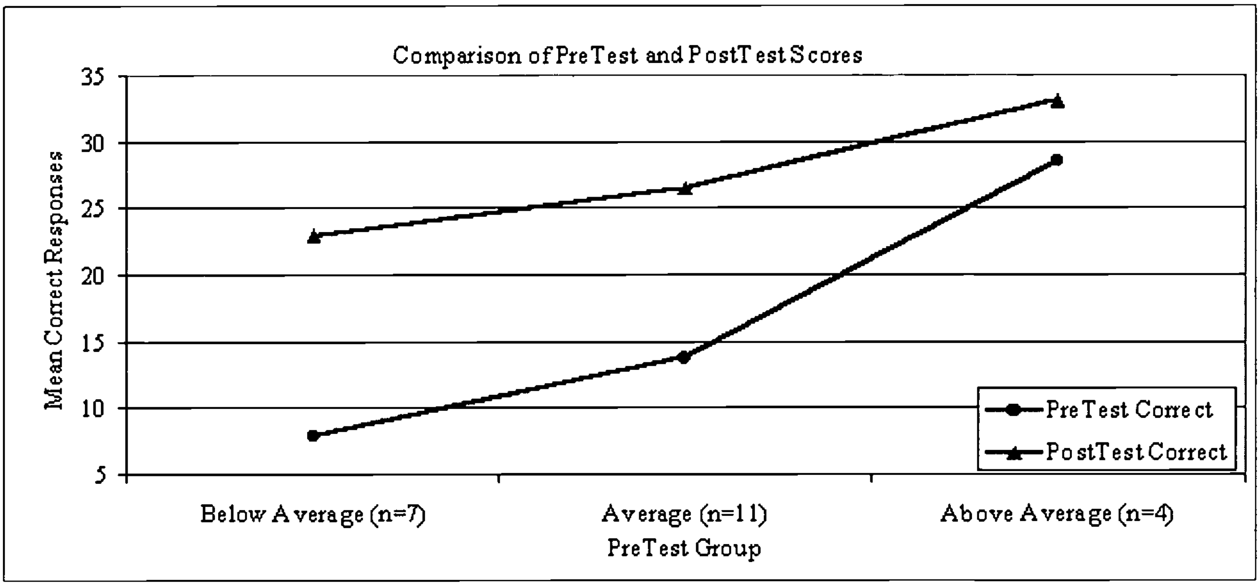


FIGURE 4
COMPARISON OF IMPROVEMENT BY RECALIBRATION GROUP
n = 22

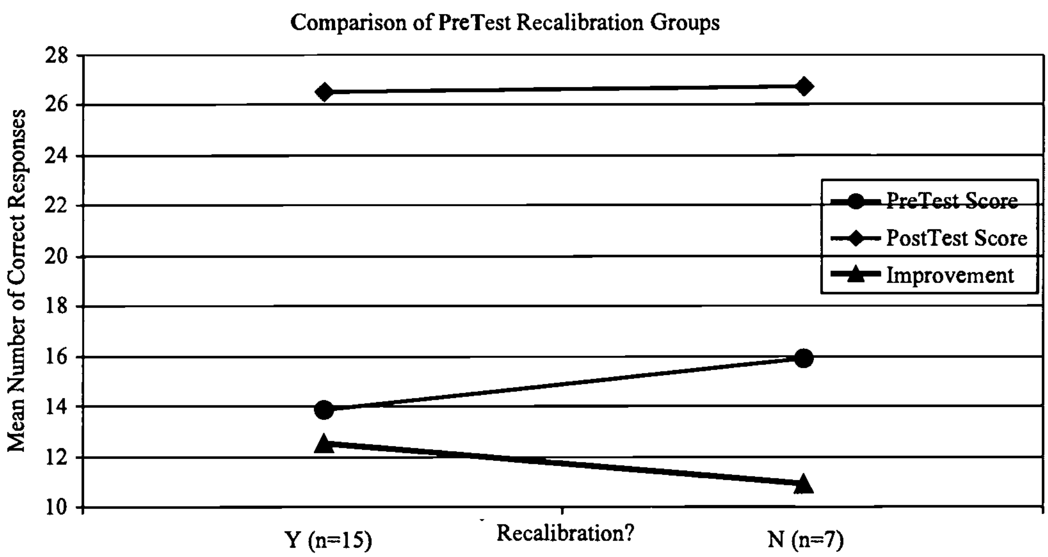
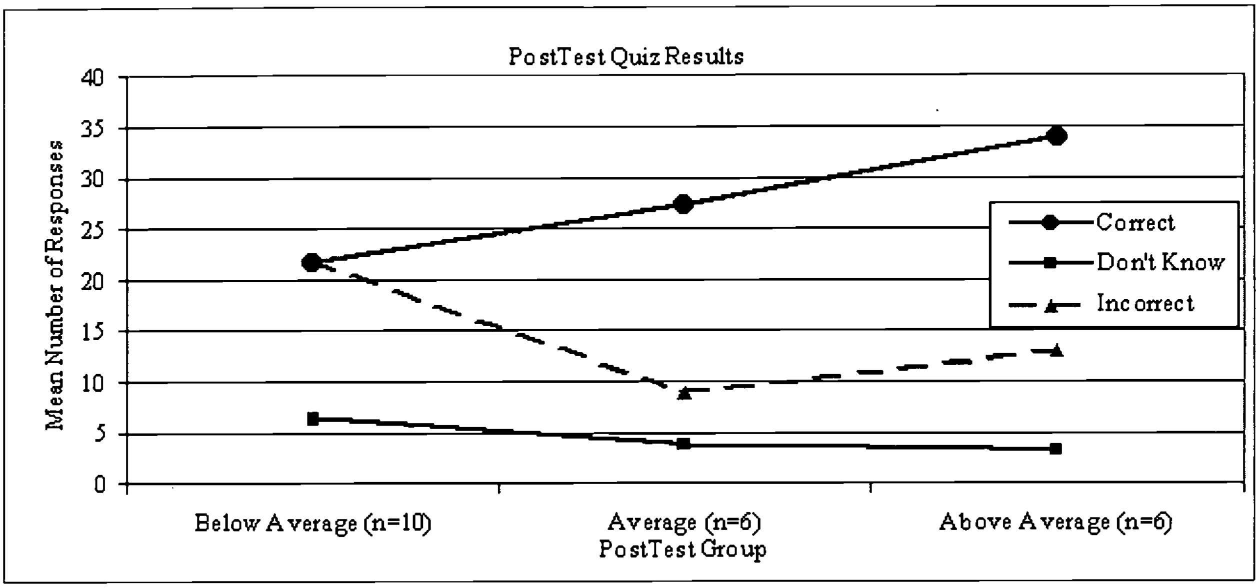


Figure 5
Posttest Quiz Results
n=22



Finally, posttest groups were formed in the same manner as pretest groups. Again, there were no students in either the far below or far above average groups. At the end of the course, ten students were below average, six average, and six above average. Figure 5 shows the mean number of correct, incorrect, and don't know responses for each posttest group. It is interesting to compare Figure 5 to Figure 1. Notice that the number of incorrect responses for the below average group is much higher on the posttest than on the pretest, more than double. At the same time, the number of don't know responses dropped for all groups.

DISCUSSION

Are any of these observations statistically significant? Unfortunately, errors in data collection resulted in our having fewer than half the observations we hoped to acquire over the course of the summer term. As a result, we do not have enough data at this time to do the analysis we had planned for this conference. We are, however, still collecting data and hope to present a more meaningful analysis in the near future.

Nonetheless, there are some encouraging observations to be made. Interestingly, and unexpectedly, recalibration seems to have occurred as a result of taking the multiple-choice quiz. It is difficult to explain why, in the absence of any feedback on actual performance, students would recalibrate in such a dramatic fashion. In the words of one author, "it looks like we scared 'em."

To confirm this, an analysis of the pretest data for the Fall 2000 term was performed to determine if what appears to be recalibration is merely a test-retest phenomenon. Because the first and second metacognitive instruments are not identical., the possibility of a test-retest problem seemed small. However, several students in the original study failed to complete the second metacognitive instrument, saying it was a duplicate of the first. (Those observations were subsequently discarded.) However, given the likelihood that participants perceive these two instruments to be the same, it seemed best to consider the possibility that what appears to be recalibration is nothing more than a test-retest problem.

Two different sections of the computer literacy course, taught by two different faculty members, were used for this analysis. In one section, the same instrument packet and protocol as were used in the Summer 2000 term were used; 34 complete observations were collected. In the second section, the multiple-choice quiz was replaced by a questionnaire asking students to provide some background information for the instructor. In addition, rather than receiving the second metacognitive instrument, which refers to pretest performance, these subjects were asked to complete a second copy of the first metacognitive instrument. A total of 31 complete observations were collected from the second class.

Recalibration scores were computed as the difference between the second self-assessment and the first. An ANOVA was performed to examine differences between first self-assessment, second self-assessment, and recalibration scores for the two classes. There was no significant difference in first self-assessment scores for the two groups; $p = 0.357$. However, both the second self-assessment and the recalibration means were significantly different; $p < 0.001$. In fact, 16 of the 34 participants who received the multiple-choice quiz recalibrated while none of the 31 participants in the other class changed their self-assessments.

The above analysis supports the idea that recalibration is occurring simply through exposure to course concepts on the multiple-choice quiz. In addition, faculty who have administered the quiz report that fewer students approach them about "testing out" of the course than in previous semesters. Although we cannot quantify this, it does support the idea that students adjust their expectations of course content or their self-assessments of course knowledge as a result of taking the quiz.

Second, either incorrect or don't know responses may provide an alternative measure of metacognitive miscalibration, perhaps eliminating the need for the metacognitive instruments. Looking at Figure 1 with this in mind, the above average group is more miscalibrated than the average and below average groups on the pretest. While the above average students clearly know more than their peers, they still scored very poorly on the pretest quiz; they do not know as much as they believe they do and, in this sense, are highly miscalibrated. By the time of the posttest, when all participants have been exposed to the same course material., the below average group is less well calibrated then the average and above average groups (Figure 5). This is consistent with claims that with domain competence comes the ability to make more accurate self-assessments; competence begets metacognitive (re)calibration.

Finally, while the study that triggered pursuit of this research (Kruger & Dunning, 1999) examined metacognitions at a micro level (judgments were solicited for each question), the current study takes a more macro approach (a single judgment for the entire body of knowledge). It is encouraging to see the same pattern of miscalibration coming from the macro approach as was seen in the micro approach.

CONCLUSIONS AND FUTURE RESEARCH

It is difficult to draw any meaningful conclusions from such a small data set. However, we do believe that instilling domain compétence is not the only path to metacognitive recalibration. The comprehensive course pretest seems to be producing some recalibration, even without feedback on test performance. Only additional data, currently being collected, will tell if the recalibration is significant and whether recalibration leads to improved course performance.

The results we have seen thus far, combined with the informal observation that the pretest reduces the number of requests to "test out" of the course, reinforce our belief that course pretests are worthwhile. Furthermore, pretests make comparison of pretest and posttest performance possible, providing a source of encouragement and a measure of effectiveness for the faculty.

Plans for further study include several manipulations including providing feedback to students on pretest performance and providing compensation, in the form of bonus points, for both pretest and posttest performance. In addition, for the second round of data collection adjustments may be made to the multiple-choice quiz in order to raise the mean score and reduce the standard deviation, in an attempt to populate all five student groups.

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