Paper Title Improving Metacomprehension and Exam Grades of Students at Risk for Failure via Explanation and Inference Test Instruction

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Improving metacomprehension and exam grades of students at-risk for failure via explanation and inference-test instruction

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Objectives or purposes

The goal of the present research was to test the impact that instruction about text structure and the nature of inference tests, in conjunction with explanation activities, might have on metacomprehension accuracy and exam grades in an actual college course context. Of particular focus was examining whether the instruction would improve the performance of students who were most likely to struggle in their first year of college coursework.

Perspectives and theoretical framework

Students' ability to effectively self-regulate their reading and studying is impacted by the accuracy of their metacognitive assessments of comprehension (i.e., their metacomprehension). To be successful learners, students need to be able to discriminate their level of understanding across various topics (Thiede, Anderson, & Therriault, 2003; Winne & Hadwin, 1998). Students' metacomprehension accuracy is generally quite low (Dunlosky & Lipko, 2007; Griffin, Mielicki, & Wiley, 2019; Maki, 1998). It has been suggested that poor metacomprehension is often a result of readers basing their judgments of what they have understood upon cues that do not reflect the quality of their situation-model representation of the text. Commonly reported invalid cues include prior familiarity with, interest in, or superficial recall of text content, rather than readers' sense of actually comprehending how various ideas fit together into a coherent mental representation (Rawson, Dunlosky, & Thiede, 2000). However, several instructional conditions that require readers to generate information using their situation-model of the text, such as having readers engage in explanation activities, have been shown to increase the use of more appropriate cues as well as metacomprehension accuracy (Griffin, Wiley, & Thiede, 2008; 2019).

One reason why students may rely upon superficial memory cues rather than situation-model cues is because they expect to be tested on their ability to recall or recognize ideas, and not their understanding of the text (Thiede, Griffin, Wiley, & Anderson, 2010). Beyond the impact on metacomprehension judgments, this testing expectation is likely to directly impact how students read and study, which may impede their ability to perform well on exams, especially those that require inferences and assess the quality of one's situation model.

The above obstacles to effective self-regulated study may be particularly important for students who are at-risk for failure in college-level coursework. Students may be under-prepared or at-risk for failure based on a number of reasons, including having less-developed academic skills (such as reflected by college-readiness scores), lacking social support from those with college experience (first-generation college students), less fluency with the instructional language (ESL), or a host of indirect factors related to the obstacles and lack of opportunities that are associated with lower family income and neighborhoods (Richardson, Abraham, & Bond, 2013).

Of particular importance in this study was exploring the potential benefits of explanation generation for at-risk students, who have been shown to have particularly poor metacomprehension accuracy (Thiede, Griffin, Wiley, & Anderson, 2010). These students enter college less-prepared for college-level coursework, are less likely to have attended schools providing opportunities such as AP courses, and may be less likely to have been exposed to assessments that depend upon reasoning and inferences (Adelman, 1999). In first-year college courses, part of the struggle for these students may stem from continuing to apply an ingrained reading-for-memory approach that may have been generally sufficient in secondary education, as opposed to a reading-for-understanding approach that is needed in college (Griffin, Wiley, & Thiede, 2019; Thiede, Redford, Wiley, & Griffin, 2012). Less-skilled readers may also benefit from direct instruction about the nature of inference test items, how they relate to the structure of the texts, and how they require making connections among various parts of the text (Hall, 2016; Hebert, Bohaty, Nelson, & Brown, 2016).

The goal of the present research was to test the impact that instruction about text structure and the nature of inference tests, in conjunction with explanation activities, might have on metacomprehension accuracy and exam grades in a gateway college science course. One specific area of focus was examining whether these activities would improve the performance of students who were most likely to struggle in their first year of college coursework.

Methods, techniques or modes of inquiry

These hypotheses were tested in an experimental study. Participants were 320 students enrolled in a 100-level Introduction to Psychology course, of which 282 students provided complete homework data. Specific to the results of relative metacomprehension accuracy, 97 students had indeterminate scores due to a lack of intra-individual variance in their judgment magnitudes and had to be excluded from that analysis. (There were no differences between the excluded students with missing data and those retained in analyses in either ACT scores or high school GPA.) Four variables collected as part of a background survey (ACT score, ESL status, whether either parent had attended college, and whether students qualified for free or reduced lunch anytime during K-12) were combined into a composite *at-risk-for-failure* measure.

At the start of the class, all students completed an online homework assignment to assess their initial pre-instruction baseline level of metacomprehension accuracy. They studied 6 excerpts from their textbook on 6 different topics. They were then asked to make a judgment of how many questions out of 5 they thought they would get correct on a quiz testing their understanding of the content of each excerpt. Then they took a 5-item multiple-choice inference test on each topic. In weeks two and three, students completed a set of online homework activities in which they were prompted to engage in generating explanations while re-reading the textbook excerpts used in the first homework.

Students in the explanation-only condition generated explanations for all 6 textbook excerpts, while students in the augmented condition only generated explanations for 4 textbook excerpts. They were shown the other 2 excerpts as examples in the instructional lessons about text structure and the nature of inference test items. The lessons scaffolded learning by noting how each text first presented a claim or theory about some aspect of human psychology or behavior, then presented descriptions of related research studies including the methods and how the results supported the psychological theory. The lessons then explained the difference between a memory and an inference test question. For each question, it was noted that the correct answer was not explicitly stated in the text, and highlighted the parts of the texts that were needed to infer the correct answer and rule out the incorrect options. Test questions from the first homework assignment were used as examples. To control for the augmented condition seeing the correct answers to some of the test items, the explanation-only students were also presented with the correct answers to these items. In a final homework assignment, students in both conditions completed a transfer assessment of metacomprehension following the same procedure as the first homework, but with a new set of texts and tests on 6 different course topics.

Data sources, evidence, objects or materials

Two measures of metacomprehension accuracy were computed: confidence bias and relative accuracy. Confidence bias was the average of the signed difference scores between each student's metacomprehension judgment (the proportion out of 5 they expected to get correct) and the proportion they actually got correct for each of the tests. Scores closer to zero reflect greater accuracy, while more positive scores indicate greater overconfidence. Relative accuracy was the intra-individual correlation between each student's set of judgments and set of test scores across the 6 texts, with higher scores reflecting greater accuracy. Both measures of metacomprehension were analyzed using mixed ANOVAs (pre-instruction, transfer x explanation-only, augmented). Both ANOVAs were also run as ANCOVAs, entering the at-risk-for-failure composite score as a covariate. The pattern of results remained the same, and no effects of the covariate were seen for either measure.

In addition to these measures used to track changes in metacomprehension accuracy, effects on learning outcomes were tested using students' scores on the second and third course exams. (Although similar results were observed for the first exam, it was not included in the analysis because it covered the same topics used for the homework activities.) Exams two and three covered different chapters and topics so there would be no direct impact of the intervention on comprehension of this material. Thus, any improvement on these exams reflects an indirect effect in which students had to transfer the skills learned in the homework activities toward learning later material for the course, beyond the content that was directly covered in the instructional lessons.

Results

As shown in Figure 1, all students were quite overconfident at the pre-instruction baseline assessment but overconfidence was significantly lower on the transfer assessment. This reduction in overconfidence was not moderated by condition. Figure 1 also shows that relative metacomprehension accuracy at the start of the course did not differ from zero. However, there was a small, but significant, improvement from the pre-instruction baseline to the transfer assessment using a different set of texts and tests. This improvement in accuracy was not moderated by condition.

Figure 1: Metacomprehension Accuracy

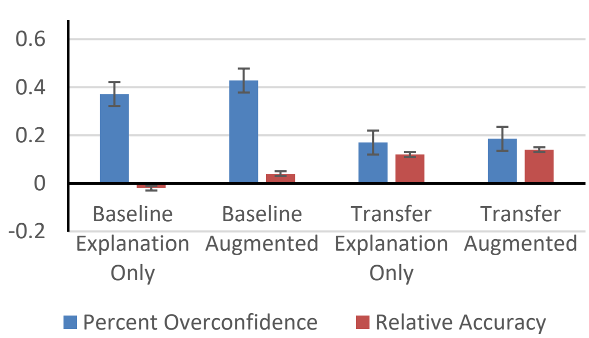
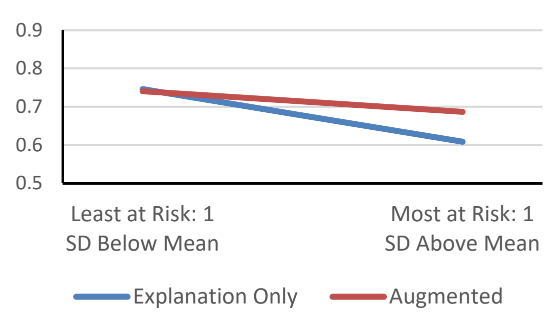


Figure 2: Course Exam Scores as a Function of At-Risk Status and Condition



Multiple regression was used to predict course exam scores. Both condition and the at-risk-for-failure composite were significant predictors of exam performance for the course. However, these were qualified by a significant interaction. Figure 2 shows the estimated exam grades for both conditions at the mean and at +/- 1SD of at-risk-for-failure composite scores (higher scores meaning more at risk for failure). In the explanation-only condition, the exam scores for students at +1SD were 12.5 percentage points lower than students at -1SD, which is more than a full letter grade on a typical grading scale. However, students at +1SD were especially helped by the augmented instruction, such that this difference from students at -1SD was reduced by half.

Scholarly and scientific significance

Previous studies on relative metacomprehension accuracy have generally reported relatively low accuracy in laboratory contexts (Thiede, Griffin, Wiley, & Redford, 2009). However, few studies have explored relative metacomprehension accuracy among highly similar topics such as readings within a real course context. Studies that have used texts on similar topics generally report poorer performance consistent with the results seen here (Griffin, Mielicki, & Wiley, 2019). Although minimal baseline accuracy in monitoring comprehension was seen in this authentic course context, the present results are promising in that they suggest that teaching students to engage in activities like explanation can help reduce overconfidence and improve accurate monitoring of comprehension.

It is important to note that the transfer assessment used different texts and tests from the prior homework activities. Therefore, while small in size, the changes in metacomprehension were not merely a direct influence of additional exposure to the assessment materials. The transfer assessment also did not include a prompt to explain. The improvement in accuracy seen from the baseline to the transfer assessment suggests that students transferred and applied metacognitive strategies that they acquired from the homework activities to the new set of texts.

Although the metacomprehension improvements were not enhanced by adding lessons about the rhetorical structure of the text and its relation to answering inference test questions, these added lessons had a notable impact on the learning outcomes for the course, as evidenced by differences in exam scores. Further, this effect was largest for students who were most at-risk-for-failure, reducing by half the course performance gap between them and students who were considered least at-risk-for-failure. This suggests that knowledge about text structure, the nature of inference tests, and how to answer inference items are malleable factors that when provided may help to eliminate difficulties that many students experience as they transition from high-school to college (Adelman, 1999). Also, these results add to findings from other research programs showing how the use of explanation activities can improve understanding (Aleven & Koedinger, 2002; Chi, 2000; Renkl, 1997) by suggesting that some students may benefit more when explanation activities are accompanied by additional instruction or practice (McNamara, 2004).

Since course exam scores heavily determine course grades, and therefore GPA, completing homework activities such as these to provide training as soon as students enter their first gateway science course may pay downstream benefits in improving college retention rates. Further, because the lessons had an effect on exam performance for new topics, this suggests students were able to transfer and apply the general principles and concepts they learned about text structures and inference tests on their own. Future work will explore whether these homework activities may also have a more general benefit on performance even in other courses.

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