Domain-General Metacognitive Instruction Reduces Productive Learning Behaviors and Performance?

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Abstract: Metacognition is critical to self-regulated learning, but can a domain-general intervention improve college students' course performance? We compared an intervention teaching metacognitive knowledge and skills against one in which students read feature news articles related to course content. Students in the metacognitive condition performed *worse* on the final exam than students in the reading condition when controlling for prior metacognitive awareness. We discuss future directions for understanding how metacognitive interventions impact students' learning.

Major issues and significance

Metacognition, or the process of thinking about one's thoughts, strategies, and learning, plays a crucial role in self-regulated learning (Winne, 1995). Students must be able to recognize what they do not understand, plan and execute an appropriate course of action, and evaluate its effectiveness. Experiments testing interventions to promote metacognition have typically involved extensive, in-class training directed by researchers or instructors (Dignath & Buttner, 2008), which limits applicability outside the context of the study. Zepeda, Richey, Ronevich, and Nokes-Malach (2015) found that an intervention targeting declarative knowledge about metacognition and the application of metacognitive skills to course content improved middle school science students' motivation, conceptual physics knowledge, and course performance. Results raised questions about how the intervention affected students (e.g., were they studying more? making better use of resources?) and whether a similar intervention could help older students, who tend to be better but still flawed metacognitive thinkers (Metcalfe, Eich, & Castel, 2010).

The goals of the current work are threefold: First, we seek to test a metacognitive intervention among college students. Given that adults' metacognitive skills plateau, and that college students typically represent a selective group of high-performing students, it is not clear they will benefit from practicing metacognitive skills. Second, we aim to adapt prior research by creating a domain-general intervention. Most prior work has customized the intervention to incorporate problems or activities from the course in question. While this has often proven effective, it creates a barrier for teachers wishing to apply existing interventions in their classes. Third, we are collecting fine-grained data within a learning management system on students' course behaviors. This rich dataset will provide greater insights into the learning behaviors associated with levels of metacognition and the effects of a metacognitive intervention.

Methodology

Students were from a large, public university in the Midwest enrolled across five sections of two introductory-level educational psychology courses: one section of an intro-level course for non-majors taught by one instructor (64 enrolled) and four sections of an intro-level course for majors taught by two instructors (138 enrolled).

All students were asked to provide consent to analyze their course data; they were informed that they would be completing all course activities regardless of consent. Data from 27 students were removed from analyses because the students either did not provide consent, were enrolled in both courses, or participated in the pilot study conducted the previous semester in a different course. As a result, the final sample included 54 students in the first course and 128 students across four sections of the second course.

Both experimental and control materials consisted of self-guided, out-of-class activities, with students randomly assigned to the experimental or control condition at the individual level. The experimental materials focused on three critical metacognitive skills – planning, monitoring, and evaluation – and three types of metacognitive knowledge – personal, strategic, and conditional. We modeled the intervention materials after another metacognition intervention that improved learning and motivation among middle school students (Zepeda et al., 2015). To make the current materials domain general and broadly applicable across courses, students chose the assignments they wanted to target with each activity. The control condition received additional readings about course-relevant concepts from the popular press, along with a series of comprehension questions to ensure they were reading the materials. Readings were selected to be relevant to the course but to not directly review content that would be on any course assessments. For example, when learning about operant conditioning, students receive a reading about B.F. Skinner's pigeon-guided missile invention during World War II. The materials across

conditions were similar in length and style, so that any behavioral, motivational, or learning differences between the conditions could be attributed to the content of the intervention. Due to logistical constraints, students in the non-major course completed the intervention in eight segments, while students course for majors completed the intervention in four double segments.

Students received extra credit for completing surveys at the beginning of the semester and immediately before the final exam on which they self-reported their planning, monitoring, and evaluation (Metacognitive Awareness Inventory; Schraw & Dennison, 1994) and their academic procrastination (short form; Yockley, 2016) on six-point Likert scales. We also collected data on students' course behaviors within the online learning management system for each course, including how far ahead of deadlines students accessed major assignment instructions, how far ahead of deadlines students submitted work, how often students viewed their grades, and whether students accessed optional course resources. For the present submission, we focus on how far in advance of deadlines students submitted their intervention activities during the second half of the course. To examine the impact of the intervention on learning, we collected students' scores on the final course exams.

Results and conclusions

We conducted a series of one-way analyses of covariance (ANCOVAs) comparing students' post-intervention levels of planning, monitoring, evaluating, and procrastination across conditions, controlling for each corresponding pre-intervention variable. Results revealed no significant differences (Table 1). An ANCOVA of average submission times relative to deadlines that controlled for pre-intervention procrastination also revealed no condition effects (Table 1). An ANCOVA comparing students' final exam grades across conditions and controlling for pre-intervention levels of planning, monitoring, and evaluation indicated a small effect of condition, with students in the metacognitive condition performing *worse* on the final exam than students in the control condition (Table 1).

While students in the metacognitive condition did not differ from students in the control condition on levels of metacognitive awareness or procrastination did not differ, the intervention reduced their final exam performance. Further analyses of the rich behavioral data collected, along with the content of students' intervention responses, may provide greater clues regarding the reasons the metacognitive intervention reduced students' learning outcomes. Based on these results, a domain-general metacognitive intervention might not be beneficial in college classrooms, at least without a better understanding of the short- and long-term behavioral effects of the intervention. We will encourage discussion of this curious result and more details are to come with continued analyses.

Table 1: Preliminary results of ANCOVAs with adjusted marginal means

	F	p	η^2_p	Metacognitive condition M (SE)	Control condition M (SE)
1. Planning	0.01	.94	.00	4.12 (0.07)	4.12 (0.07)
2. Monitoring	0.00	.98	.00	4.11 (0.08)	4.11 (0.08)
3. Evaluating	0.90	.34	.005	4.05 (0.07)	4.15 (0.07)
4. Academic procrastination	0.66	.42	.004	4.13 (0.07)	4.12 (0.07)
1.15	0.68	.29	.025	23.64 (5.84)	32.38 (5.59)
6. Final exam	4.02	.047	.024	75.42 (1.43)	78.87 (1.48)

References

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