

Probing the Elaboration of Metacognition

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Abstract: At the St. Louis College of Pharmacy, a teaching group has been working on the development of student metacognitive skills through using ‘Two-Stage Cooperative Testing’ in the Physiology course sequence. A research group has been administering the Metacognitive Awareness Inventory (MAI) and tracking students through the curriculum to see what relationship between MAI scores and success in the program might exist. In the fall of 2017 the two groups found a natural point of connection and began comparing course grade information with MAI results. The result was a demonstration of both a slight positive correlation between the MAI and overall semester GPA ($r = 0.313$, $p < 0.001$) and a slightly stronger correlation between the Knowledge of Cognition sub-score and course grades specifically in Medical Physiology ($r = 0.377$, $p < 0.001$). The relationship between the Regulation of Cognition sub-score and Medical Physiology course grades was also significant but less robust ($r = 0.273$, $p < 0.001$). Future collaboration will continue investigating how metacognition in students might be more systematically fostered.

Background

Cooperative Learning is a powerful teaching method in which small groups of students work together in order to maximize their own and each other’s learning (Johnson & Johnson, 1999). One of the most powerful cooperative learning techniques, however, has received relatively little attention over the years compared to other techniques. This technique is called ‘Two-Stage Cooperative Testing.’ Two-Stage Cooperative Testing involves students first taking an exam individually, as in traditional testing, and then later taking the same exam with a learning group (Zipp, 2007). The exam grade ends up being a weighted combination of their individual and group scores. This technique takes advantage of a phenomenon termed the ‘Testing Effect’ (Roediger & Karpicke, 2006). The “testing effect” refers to the finding that after

an initial study opportunity and knowledge assessment, future testing (over the same material) is more effective for long-term retention of facts and concepts than restudying. The Two-Stage Cooperative Testing paradigm was tested in an undergraduate Human Physiology course. It was found to be more effective at stimulating long-term retention of physiology concepts than either lecture alone or a flipped classroom (Ford, Kleine, & Pinaire, 2016). Thus, it is now used in the Medical Physiology course at St Louis College of Pharmacy (STLCOP) for First Year Pharmacy Students. The course coordinator believes that this allows students to examine and defend their own mental models regarding physiologic mechanisms by justifying their answer choices to their peers. Additionally, the students hear their peer’s point of view and debate the merits/flaws

of each proposed mental model. In so doing, the instructor hopes that incorrect mental models may be reformulated into more correct ones and that storage of these models in long term memory is stimulated. The justification for using this testing methodology is spelled out for the students in the course syllabus thusly; “This method is used as a means to engage students in metacognition and allow for flawed mental models to be rewritten based upon new (more correct) information.” (Ford, 2017, p. 4).

Beginning in 2014, a separate research group initiated administering the Metacognitive Awareness Inventory (MAI) to incoming first-year undergraduates. The MAI is a 52-question assessment designed to measure adults’ metacognitive awareness (Schraw & Dennison, 1994). Items in the MAI are classified into eight subcomponents subsumed under two subdomains, knowledge of cognition (KC) and regulation of cognition (RC). The KC subdomain corresponds to what students know about themselves, their strategies, and the conditions under which these strategies are most useful. The RC subdomain corresponds to knowledge about how students plan, implement, monitor, and evaluate their own learning.

Initial evaluation of the results from freshmen in 2014 indicated no statistically significant correlation between the MAI and incoming ACT scores (Weck & Gaebelein, 2015) or Freshman GPAs (unpublished). In Fall 2015 MAI results were collected not only from freshmen, but also from students in the first professional year (P1) of the Doctor of Pharmacy program. The data indicated a slight positive correlation between MAI scores and semester GPAs for P1 students,

but not for freshmen (Zhang, Gaebelein, Vineyard, & Weck, 2017).

In Fall 2017, many of the students tested in 2014 as incoming Freshmen were tested again as professional year 1 (P1) students¹. Fall of 2017 thus marked the first year of ‘test-retest’ possibility using the MAI at STLCOP. The 2017 MAI scores demonstrated no significant change in mean MAI between the freshman test and the P1 retest (overall average change -0.27) but did repeat the measurable positive correlation between the MAI scores and P1 semester GPAs as had been seen in the 2015 data.

This led to our asking the question, ‘Which courses in P1 might individually show an even stronger relationship between course grade and MAI scores?’ Examination of the course syllabi uncovered two P1 courses that made explicit reference to the development of self-learning and critical thinking. One such course was Medical Physiology. It was this natural overlap that allowed the two previously independent efforts to begin sharing data and to work together.

Methods

The MAI was administered using a 5-point Likert scale to all incoming P1 students during a regular class period in a required course at the start of the Fall 2017 semester (N = 252). The informed consent obtained for inclusion in this study included permission to link MAI scores with final course grades (STLCOP IRB #2104-15). Two courses, BIOL4101 - Medical Physiology (MP) and PHSC4101 - Principles of Drug Action (PDA), were identified as having syllabi explicitly indicating metacognitive skills would likely be required for successful completion of the

¹ Only 88 total responses met the criterion of a signed consent form (n=80 both 2014 and 2017, n=5 2014 only, and n=3 2017 only) AND a full MAI attempt 1 AND a full

MAI attempt 2. This test-retest group of 88 thus represents 44% of the original 2014 FR class and 35% of the 2017 P1 class.

course. End of term course grades were compiled and de-identified by the Office of Institutional Research. Letter grades for each course were given numerical values in accordance with the 2017-2018 Academic Catalog of the St. Louis College of Pharmacy (which includes + and – grades). Statistical analyses were performed using Microsoft Excel 2013.

Results

Data concerning the Medical Physiology course grades of 149 students (59% of the P1 cohort, which includes the 88 test-retest students) who gave informed consent is presented here. The Pearson Correlation for student's grades in MP showed a small but statistically significant ($p < 0.001$) positive correlation with MAI scores ($r = 0.313$). Correlation of the Knowledge of Cognition (KC) subdomain of the MAI and course grades was shown to be statistically significant ($p < 0.001$) in MP ($r = 0.377$). Regulation of Cognition (RC) subdomain of the MAI also showed a smaller but still statistically significant ($p < 0.001$) correlation in MP ($r = 0.273$).

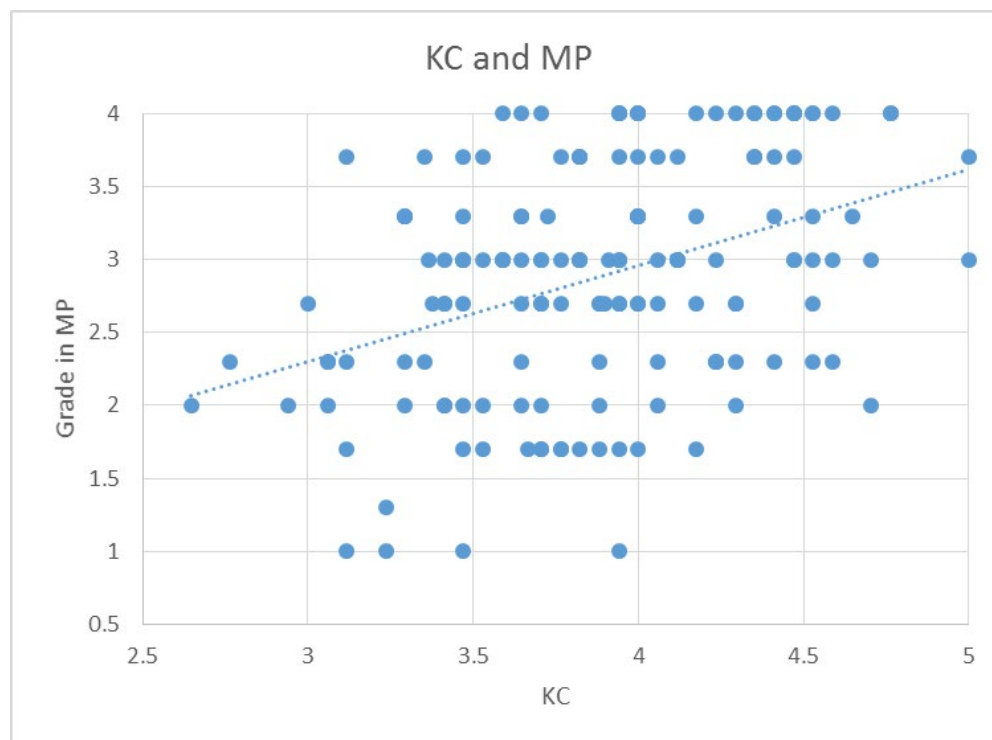


Figure 1: Correlation of KC subdomain and course grades in Medical Physiology

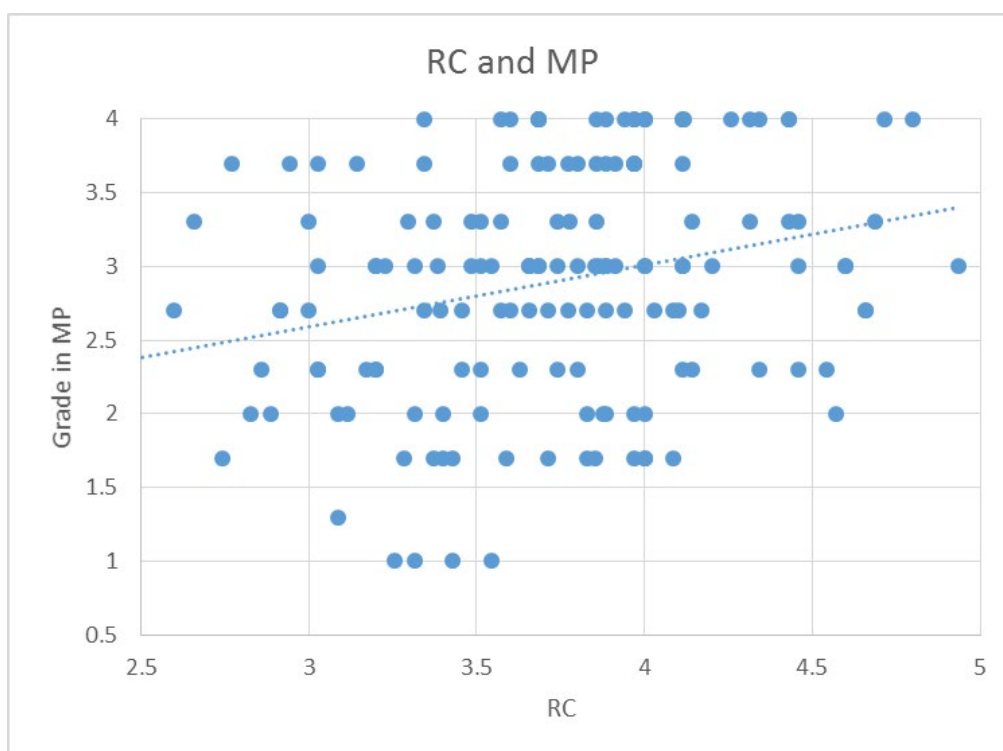


Figure 2: Correlation of RC subdomain and course grades in Medical Physiology

Conclusions and Future Implications

The potential role for metacognition in a variety of educational settings is very tantalizing, but difficult to measure or systematically document (Avergil, Lavi & Dori, 2018). The positive correlation between MAI and course grades in the Medical Physiology course suggests that students with stronger metacognitive awareness as assessed by the MAI, tend to achieve greater academic success in this course. Of unknown significance are the findings that while the average MAI score was actually lower for the test-retest group (3.74) compared to the P1 students new to the school in Fall 2017 (3.80) and their collective average in 2014 (4.02), the correlation of 2017 MAI, and RC to MP course grades was higher for the test-retest

group, but the correlation of KC to MP course grades were higher for the new P1 students.²

The MP course was specifically chosen for analysis because the course syllabus explicitly describes metacognitive development (utilizing the Two-Stage Cooperative Testing paradigm) as a formal part of the course. Our data suggest that, indeed, successful completion of this course is correlated to the presence of metacognitive skills. The question remains open as to whether the level of metacognitive skill measured at the beginning of the semester was the same or had changed over the course of the semester due to the testing strategy. Administering the MAI at the beginning of the course and at the end would answer that question. The results obtained raise new questions about the

²

number		Ave MAI	MP grade	MAI v MP		KC v MP		RC v MP	
				r=	p<	r=	p<	r=	p<
149	2017 over all	3.7 673 11	2.8 785 23	0.313	0.001	0.377	0.001	0.273	0.001

88	2014 -17 re- test	3.7 477 43	2.9 693 18	r=0.349	p<0.001	r=0.394	p<0.001	r=0.321	p<0.005
61	2017 only P1	3.7 955 39	2.7 475 41	r=0.290	p<0.005	r=0.400	p<0.005	r=0.228	p>0.05

possibility and impact of developing metacognition longitudinally throughout a one-semester course or the entire professional pharmacy program. Future plans include replication of this study with next year's P1 students to answer the question of increasing metacognitive awareness utilizing a

cooperative testing strategy. In addition, this current cohort will be followed through the rest of their pharmacy program to establish the longevity of the relationship between MAI and academic success in the Doctor of Pharmacy (Pharm. D.) program.

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