Not Your Ordinary Supplemental Instruction: A Focus on Metacognition

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Author Biography

Angela Spencer, PhD, is an Associate Professor in the Department of Chemistry and Physics at Augusta University in Augusta, GA. She teaches courses in general and biological chemistry as well as a supplemental course for students in general chemistry. Dr. Spencer also serves as Director of the NSF-funded S-STEM program, Promoting Opportunities and Pathways for Undergraduate Persistence in STEM (POPUPS) at Augusta University. Dr. Spencer's passion is helping undergraduates learn and excel in the classroom and the laboratory through engaging instruction and mentoring.

In order to improve student retention, progression and graduation at Augusta University, a new course was designed to supplement Principles of Chemistry II (CHEM 1212). The novel course was atypical for Supplemental Instruction (SI) which has been around since the 1970s and generally involves students voluntarily attending a help session led by an SI supervisor, the course instructor, or often, an undergraduate student who successfully completed the course.

The supplemental course (CHEM 1950) is a one-credit, one-hour per week course taught by a faculty member currently teaching CHEM 1212. Students register for CHEM 1950 and receive a letter grade based on their performance on course activities and assessments. Students who are at-risk for earning a D, F or W in CHEM 1212 are recruited for the class. At-risk is primarily determined by a grade of C in the pre-requisite course and/or a failing score on a pre-test given on the first day of class in CHEM 1212. The supplemental course is structured such that students who attend class, participate in class activities, and complete assignments with reasonable success will earn at least a C in the supplemental course. Traditionally, two sections of the course are offered each semester with section enrollment limited to 28 students.

Goals of Course Activities

With an overarching goal of improving student success, the activities in the supplemental course are designed to 1) provide students with needed problem-solving skills through the use of active learning strategies; 2) improve student confidence levels in chemistry as confidence is linked to academic performance and persistence for college students in STEM; 3) provide students with metacognitive practice in order to improve success beyond general chemistry; and 4) ultimately improve success rates in CHEM 1212.

Description of Course Activities

For the purposes of this essay, the focus will be on course activities designed to improve student confidence levels and promote metacognition. These specific course activities include:

- Brief 'lecture' introduction during the first few minutes of class (mostly "Q and A")
- In-class practice problems in assigned groups
- Reading assignments in *The A Game*
- Reading reflections based on *The A Game*

One of the underlying goals of the course was to provide a safe environment for students who struggled in the pre-requisite course (Principles of Chemistry I, CHEM 1211) to work on chemistry problems with their

peers and solicit help from the instructor when needed. The smaller class size and low-stakes aspect of the course seemed to create a relaxed environment where students freely discussed course topics without fear of judgement from others. To further lower anxiety arising from asking questions in front of their peers, students submitted anonymous hand-written questions to the instructor before class. These questions were addressed at the start of class and often ignited an engaging question and answer session regarding confusing problems on pre-class quizzes, tests (in the main course) or homework problems. After this initial Q and A session, students were assigned to small groups (3 or 4 students) for problem-solving exercises designed to assist students in identifying concepts they did not understand. During this time, the instructor moved around the classroom, answering questions and providing answers to the assigned problems with appropriate feedback. The instructor consistently praised the students for their efforts and their understanding of difficult concepts. These aforementioned strategies were implemented in order to improve confidence and metacognition.

To further promote metacognition, students were asked to read Kenneth Sufka's book entitled, *The A Game: Nine Steps to Better Grades*. Dr. Sufka's book is a quick, easy read that provides students with simple solutions for nine common mistakes college students make that hinder their success. In addition, the book highlights effective study strategies and best practices for success. After reading excerpts from the book, students completed reflections requiring an evaluation of their own study practices, test performance(s) and thoughts on the effectiveness of study techniques (their former practices and the new techniques they implemented based on readings).

Reflection

Students were asked to rate aspects of the course on a scale of 1-4 with 4 being very helpful and 1 being not very helpful. Students rated lecturing by the instructor and test reviews (in groups) during class as being very helpful (Table 1). Students rated working practice problems in groups as helpful. According to the students, less helpful aspects of the course were reading and reflecting on *The A Game: Nine Steps to Better Grades.*

Table 2: Results of post-semester survey from fall 2019 relating how helpful students rated each class activity (n = 38).

Class Activity	Average score*
Lecturing by instructor	3.92
Working examples in groups	3.34
Test reviews in class	3.95
The A Game reading	2.42
The A Game reflections	2.29

*Survey scale: 1 = not very helpful; 4 = very helpful.

To provide evidence of confidence gains made during the course of the semester, students took a survey during the second week of classes and again on the last day of class. In every area, the average responses increased from week 2 to week 15 (Table 2). In fact, despite the lower helpfulness ranking for *The A Game* reading assignments and reflections, students reported greater confidence in their ability to use effective study practices at the end of the course. In addition, students reported spending more hours studying for CHEM 1212 and reported using a greater diversity of study methods, including two methods discussed in *The A Game* (concept mapping and notation reduction).

Table 3: Results of survey of confidence levels related to various aspects of chemistry required to be successful in the course (fall 2019 data; n = 41 for week 2; n = 38 for week 15).

Rate your level of confidence in your ability to…..	Average response Week 2* (out of 5)	Average response Week 15* (out of 5)
understand key concepts of chemistry	3.2	3.8
solve chemistry problems	3.3	3.9
visualize key concepts of chemistry	3.0	3.7
use effective study practices	3.1	3.9
apply concepts from CHEM 1211 to CHEM 1212	3.4	3.9
understand new concepts in CHEM 1212	3.2	4.1

*Survey scale: Low = 1; high = 5.

Table 4: Results of survey for study methods utilized by students during fall 2019 term. (n = 41 for week 2; n = 38 for week 15)

Response	Percentage of Student Responses*	
	Week 2	Week 5
group work	26.8%	44.7%
work problems	95.1%	97.4%
concept mapping	9.8%	13.2%
notation reduction	7.3%	42.1%
watch videos	68.3%	52.6%
other**	31.7%	28.9%

*students were instructed to select all that apply
**common responses were review notes and make flash cards

In addition to improving students' confidence in their understanding of chemistry concepts and study strategies, the overarching goal of the supplemental course was to improve success rates in CHEM 1212, targeting those at-risk for DFW, but having open enrollment for any student desiring to take the course. Almost 60% of the students enrolled in the supplemental course earned a C in the pre-requisite course (a potential risk factor) with 30% earning a B and 10% earning an A. In the fall of 2019, 86% of the students enrolled in the supplemental course were successful in CHEM 1212 (36/42) compared to an overall success rate of 77% (83/107) for CHEM 1212. Not only is the supplemental course improving student success in CHEM 1212, student gains in confidence and metacognitive skills indicate that the course activities are achieving the desired outcomes. Future studies are aimed at measuring the effectiveness of the supplemental course on future chemistry course success.

For more information on the activities described for the supplemental course for CHEM 1212, email anspencer@augusta.edu.