

SUPPLEMENTAL INSTRUCTION, EVEN FOR CHEMISTRY

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Supplemental Instruction (SI) has been used at NMSU for two semesters of General Chemistry and four semesters of Organic Chemistry. In all cases, students who participated in SI out-performed the non-participants, i.e., more A, B and C letter grades and less D's, F's and W's in these chemistry courses. These chemistry classes were targeted for SI because the failure rate for them is traditionally high (40-60%), and yet they are pre-requisites for many other courses and required for various career options: chemistry, biochemistry, chemical engineering, biology, micro-biology, and other fields. Unfortunately, these chemistry courses are traditional "gate-keeper" courses; furthermore, misconceptions and oftentimes fear of these courses keep students from performing well or even enrolling in these classes. The failure rate (D's, F's, and W's for this paper) is 40-60% for General Chemistry and the failure rate compounds another 40-60% when these students "move on" to Organic Chemistry. These effects are even more pronounced for minority students because their failure rate is even worse. Therefore, the option to attempt SI for these chemistry courses was worthwhile, and furthermore, the first efforts with SI have been successful.

SI, Inception and Dissemination

SI was implemented at NMSU-chemistry as a result of an investigation by Dr. Philip Uri Treisman. Dr. Treisman first initiated SI workshops to affect the failure rate of Black students in mathematics (and later chemistry courses), especially for entering freshmen [1]. When Dr. Treisman was at the University of California, Berkeley, he wanted to know why the performance of Black students as a whole was always worse than that of other students. He investigated learning and studying methods of various ethnic groups to try to understand the poorer performance of the Black students. Incidentally, the poor performance was also true for Chicanos or Mexican American students. What he found, for example, was that Black students did not have the same study skills and effective group dynamics that the Asian students had. For the Asian students, "effective study" meant very honed group dynamic skills, well-focused objectives, and always a concerted distribution of tasks to accomplish the work that had to be completed in a particular study session. A "study session" meant just that, very limited socializing and many hours on task. In addition, Black students as a whole did not study as many hours per class credit as did the Asian students. The study factor for the Asian students was 4-5; i.e., 4-5 hours were spent studying for every hour spent in the classroom. On the other hand, Black students had a study factor of only two. A different approach for success in the mathematics and science courses was needed for the Black minority students, thus SI was initiated and implemented by Dr. Uri Treisman.

This innovative SI approach extended to Cal Poly. Sue Sparling and Bill Sydnor are directors of the two SI programs at Cal Poly. Sue Sparling was the first to initiate SI efforts in the "high-risk" mathematics courses. Bill Sydnor does the same for all other "high-risk" courses

at Cal Poly. I was invited to observe SI "in action" at Cal Poly and this experience was very interesting and exciting.

In addition, the SI pedagogy is taught and disseminated by the University of Missouri-Kansas City, and their SI program is now recognized internationally. More importantly, the Center for Academic Development at the University of Missouri-Kansas City claims that "The SI Program [was] developed by Deanna C. Martin, Ph.D. at the University of Missouri at Kansas City in 1973" [2]. As a direct influence to the NMSU program, they offer workshops in SI and SI implementation; and again, a University of Missouri-Kansas City SI workshop was very useful to help start our SI efforts at NMSU.

What is SI?

The recurring theme about SI that I am given everywhere is: "it is not about teaching, it is about learning." A quote from the SI Center at the University of Central Florida says, "the emphasis in SI is on helping students acquire and refine the learning skills essential to master course content" [3]. More and more teachers are realizing that the lecture mode is not always the most effective method to "teach" in many instances. More effective learning can also be accomplished by speaking, touching (e.g., chemical model building in this instance), physical involvement, and active participation. These ideas are not entirely new; Edgar Dale presented the *Cone of Learning* [3] in 1969! The essence of his "cone of learning" is:

After 2 weeks we tend to remember:

- 10% of what we read
- 20% of what we hear
- 30% of what we see
- 50% of what we hear and see (look at exhibit/watch a demonstration)
- 70% of what we say (participate in discussion/give a talk)
- 90% of what we say and do (give a presentation/simulate real experience/do the real thing)

As a note for those of us who "lecture," this should raise a flag! However, the function of SI at NMSU is to incorporate as many alternate pedagogical styles so that more students, each with their unique learning style, can be reached. Key phrases that we use in our own introductory workshops for the student facilitators (student peers that lead the weekly SI sessions) are: group dynamics, discussion, verbalization, writing, discovering, comparing, reasoning, sharing, development, formulate, compose, identify, analyze, organize, and even soul searching. Techniques and exercises that are used to implement the SI approach include worksheets, mock exams, games, reviewing, computer assignments, "note taking" as well as "text implementation" exercises, probable exam question generation, and many other activities and exercises.

A very important issue is that SI is not tutoring! Tutoring is typically a form of re-lecturing or re-instruction and this only places students in an information-gathering mode, again, and this is not the goal of SI. Instead, what is desired is the proactive learning involvement by students described above [3].

Finally, the most important issue is that SI is not "remedial" pedagogy. This concept is universal to all SI programs and strongly emphasized by Dr. Treisman. When referring to "remedial" approaches, Dr. Treiman states, "I questioned also the wisdom of these programs' remedial underpinning: the focus on minority students' weaknesses rather than on their

strengths” [1]. To underscore this idea, SI courses are open to all students [2]. Thus it becomes important that SI should never be presented or advertised in any manner that would imply “remedial.” Care should be taken to never give students the sense that SI is remedial because it is not. Dr. Treisman’s comment continues, “this was the leap of faith that led me to eschew the traditional remedial approaches to aiding minority students and to develop the Mathematics Workshop as a challenging honors program” [1]. SI is intended to help students excel. The Central Florida SI program states this concept in a slightly different manner, “SI is a proactive academic assistance program that focuses on historically-difficult courses and not high-risk students” [3]. SI is a radically different approach that will require much attention and dedication to keep SI “true” at NMSU.

SI at NMSU

SI at NMSU is sponsored by the National Institute of Health, NIH, as a sub-proposal of the RISE Program. I am the Principal Investigator and faculty coordinator for SI-Organic Chemistry. Each semester we hire seven undergraduate students: one student coordinator and six student facilitators. The student facilitators are actually in the classrooms facilitating SI. The student coordinator is in charge of the facilitators, being the liaison with faculty, keeping records, overseeing evaluations, documenting and filing all pertinent information, and writing final reports. This person is also in charge of the initial observation/evaluation for each of the facilitators. Note that all of the personnel are undergraduates. This was a recommendation from my visit to Cal Poly where all of the facilitators and coordinators are undergraduates. Their reason for using only undergraduates was because “the undergraduates are still moldable.” I meet with the entire group once a week to iron-out details, but more importantly to discuss pedagogy, share experiences both good and bad, and offer suggestions. We profess group dynamics, so when the entire group meets, we make group decisions and conduct ourselves as a team. Typically, each semester we lose and must replace two of six facilitators. The more seasoned facilitators have always made the transition easier for the new facilitators.

Each week, the actual SI sessions are taught in two-50 minute sessions or one-100 minute session. Each facilitator prepares a plan for their sessions of the week. The sessions are actual classes, i.e., students must register for the SI classes at the beginning of the semester. Attendance is mandatory, and in conjunction with participation this is what determines their grade. In keeping with the philosophy of SI, there is a big effort to avoid tutoring, to avoid giving “answers,” and most important, SI is never the place to do homework assigned by the Organic Chemistry instructor. SI never interferes with what happens in the actual Organic Chemistry classroom; SI is strictly supplemental.

The success with SI in Organic Chemistry prompted Dr. Kuehn, NMSU Department of Chemistry and Biochemistry, to propose SI for General Chemistry. He obtained funding from the Center for Disease Control, CDC, to offer SI at this level. Dr. Deanna Dunlavy is the faculty advisor for this effort. The entire Chemistry SI is one large team, and Dr. Dunlavy is a vital and vibrant team member. Her efforts to expand and develop SI are so appreciated and respected by the SI team.

Each semester, there is a mandatory 2-day workshop for all of the student facilitators and coordinators the week when classes start. The mechanics of operation, logistical considerations, and rules/commitments are explained. More importantly, the philosophy of SI is “practiced,” discussed, and shared in the workshop because for everyone, this is a “first.” For our very first

workshop, we invited Sue Sparling from Cal Poly to lead our workshop. Since then, we design our own workshops. The workshops are presented in collaboration with the NMSU Center for Learning Assistance and Retention, CLA&R, under the Direction of Dr. Sue Brown. Dr. Brown and the Center have expertise in SI. The person who actually designs the workshops, in conjunction with Dr. Dunlavy and myself, but more importantly presents the workshop is Terry Cook, Associate Director for the CLA&R. The CLA&R has been very important in our SI endeavors.

We now have an "SI Room" in the chemistry building, and it is dedicated strictly for our project. The SI room has two primary functions, one is for facilitators to prepare their "lessons" and the other is for all students participating in SI to use the facilities. These include six computers with educational programs for biology, general chemistry, and organic chemistry. In addition, there is a dedicated SI web site where links have already been installed, links that follow the course syllabus and textbook outline. There are also flash cards for those who need visual aids, alternate textbooks with the corresponding solutions manuals, a large board for writing, exercise sheets, posters, a large, wall Periodic Table, and we hope to add many other visual and audio aids to help in the learning process. Old exams are filed for use by anyone involved with SI. The weekly "session reports" that are submitted by the student facilitators are also on file. These include mock exams, drills, games, observations, and anything they have used in their SI sessions. Again, the emphasis is that this is not a tutoring room. We simply want to direct students to other resources for learning their material. They may be their own best resources but do not realize it, hence this resource room provides an opportunity for students to visit and use the facilities.

Results of SI at NMSU

Each semester, we collect grades to make comparisons. We classify A's, B's, and C's as passing grades. For our purposes, D's, F's, and W's are the failing grades. We have had SI for four semesters in Organic Chemistry, and each semester the students enrolled in SI have a higher percentage of passing grades and fewer students fail. Typically, about one-third of all students enroll in SI. In one particular course, the only students to earn an "A" for the entire organic class were students enrolled in SI. The final results for the Fall 2001 semester will not be tabulated until the next semester, 2002; however, for each exam given during the Fall 2001 semester, similar positive trends were observed for those enrolled in SI classes.

The Next Phase

The next phase is to collect data about which methods work best, which are the best times to offer SI, what is the optimal time for the length of a SI session, how to handle problem situations, and how to collect and organize the materials that we now use and are continually producing so that we do not have to re-invent the wheel every time. We want the facilitators using their time to be creative in how they plan to make students aware of personal learning processes.

Success in our SI program means changes in our philosophical and pedagogical approach. There is definite evolution in the attitude of our entire team, especially for the "old-timers." However, every semester we lose 2-3 student facilitators, and they must be replaced. The new personnel have to be trained, and this is where the progress seems to be slowest. But

now the “word is out” about SI and so students are aware that things are done differently, and at least there is an expectation and awareness that change is in the air. The interview process for potential facilitators has become more formal and consequently more helpful in the decision-making. Students are helping each other. There are now files of tests, activities, and how-to sheets, and even an SI room designated for SI use only! Slowly, things are improving in this regard.

The next area that needs more attention is evaluation. Certainly a comparison of SI versus non-SI performance helps. But what is the impact on minority students? We need to implement methods of evaluation. Is the student population that enrolls in SI the fraction of students that most need SI or are the students that are enrolled already the over-achievers? This is not entirely the case in our SI classes because minority students involved in any of the RISE or CDC programs must enroll in SI.

Finally, the goal is for students not to be merely successful in the particular chemistry course, but for students to acquire better learning techniques, i.e., have students discover their learning styles and even increase their own “bag of tricks.” If this is truly achieved, then these methods will carry-over to all of their other classes - now we have something! Of course the ideal situation would be that in the future, some of these same students change the way we “teach.”

REFERENCES

1. Philip Uri Treisman, “A Study of the Mathematics Performance of Black Students at the University of California, Berkeley,” 1985.
2. “Supplemental Instruction Update,” The Center for Academic Development, University of Missouri-Kansas City, Summer 2001, <http://www.umkc.edu/cad/>
3. “A Supplemental Instruction Model,” Supplemental Instruction, University of Central Florida.
4. Edgar Dale, *Audio-Visual Methods in Teaching (3rd Edition)*, Holt, Rinehart, & Winston (1969).