

# Case Study of a Successful Educational Partnership: University of Illinois at Urbana-Champaign and the Illinois Mathematics and Science Academy

by Dave DeVol, Ph.D.

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## INTRODUCTION

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This article describes partnerships between an NCSSMST member institution and a research university and the use of student-generated survey data as a means of both professional self-reflection and asking further questions. As a chemist, I have been trained to write in the style of scientists, and in fact I teach a course at the Illinois Mathematics and Science Academy on the methods of science and scientific writing. This article is intentionally not written in a scientific style; rather is written to convey a story of how a partnership between institutions naturally progressed into my current area of research into motivational issues of gifted students.

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## BACKGROUND

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When the Illinois Mathematics and Science Academy (IMSA) was founded in 1985, the state of Illinois charged IMSA with two mandates:

- Legislative Mandate 1: “The primary role of the Academy shall be to offer a uniquely challenging education for students talented in the areas of mathematics and science.”
- Legislative Mandate 2: “The Academy shall also carry a responsibility to stimulate further excellence for all Illinois schools in mathematics and science.”

The first mandate is fulfilled through IMSA’s residential academy for talented high school students, and the second

is fulfilled through outreach programs that serve students and educators throughout the state.

In keeping with the second legislative mandate, a partnership between the University of Illinois at Urbana-Champaign (UIUC) and IMSA was formed. At that time I, along with the other Advanced Chemistry (Ad Chem) teachers, were contemplating significant curriculum changes in Ad Chem. Those changes were proposed to make the Ad Chem curriculum more laboratory- and inquiry-based, and less like an AP Chemistry preparation course. A laboratory and inquiry based curriculum fits well within IMSA’s philosophy and aligns with IMSA’s Standards of Significant Learning (SSLs), (<https://www3.imsa.edu/learning/standards/ssl.php>). The IMSA SSLs are a set of standards that value constructivism and students “learning how to learn.” They are not content-based but process-based. While valuing the SSLs is important at IMSA, there is no denying that students and parents value AP scores. Thus, when I spoke with IMSA’s principal in the summer of 2008 about modifying the Ad Chem curriculum, he gave his support with the caveat that we fully explain the changes and the rationale to both parents and students (which we subsequently did at IMSA’s “Parent Day”).

At a meeting in Champaign-Urbana between IMSA and UIUC faculty and staff, I met a doctoral student in the UIUC College of Education. As a former chemistry teacher at an academy in Singapore, she was interested in science curriculum, and intended to make science curriculum the focus of her doctoral dissertation. She was intrigued by the proposed curriculum changes to Ad Chem, and

arrangements were made for her to make the study of our curriculum changes the focus of her Ph.D. thesis.

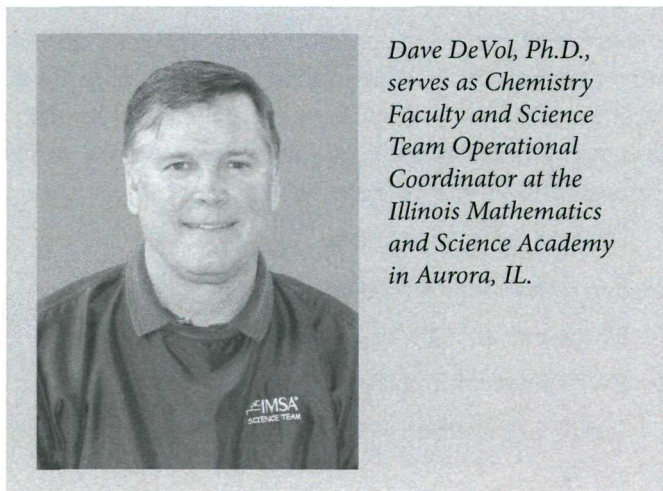
The curriculum changes to Ad Chem were made by the IMSA chemistry team during the summer of 2009, and implemented during the 2009-2010 school year. Additional changes were made in the summer of 2010, with a particular focus on writing pre- and post-lab questions that would allow laboratory experiences to drive the curriculum. The UIUC doctoral student conducted her research at IMSA during the spring and fall of 2009, and the spring of 2010. Her research consisted of observing Ad Chem classes twice per week, surveying students each of the three semesters, and interviewing students, the Ad Chem teachers, IMSA parents, and IMSA administrators. She completed her Ph.D. work in 2011, and has subsequently returned to Singapore and holds a position in the National Institute of Education. A copy of her Ph.D. thesis is in the IMSA repository for scholarly work ( <http://digitalcommons.imsa.edu/> ).

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## RESULTS

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Over the past three years, the Ad Chem teachers have collected and analyzed data on student views of the revised version of the Ad Chem course. Students were asked eight questions about the course and responded on a 5 point Likert scale (see Figure 1). Results overall have been very positive for learning attributes that we value and that align with IMSA's Standards of Significant Learning, namely thinking and analyzing, making connections, constructivism, and classroom environment. In education, we walk a "tightrope" of how much direct instruction to provide



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versus how much to allow students to learn via inquiry, laboratory experiences, reading, and collaborative work. For the prompt "Do you wish the teacher would explain more," the average student response was very close to three for all three years, indicating that we have found a reasonable balance between direct instruction and other modes of teaching.

Approximately 70 to 75 percent of IMSA students take Advanced Chemistry, making it the highest enrolled elective in the academy. It had been speculated that the reason for this is the requirement for one year of chemistry in order to apply to most colleges and universities; and this requirement is not met by the core sophomore chemistry class at IMSA, which is a one semester course. Therefore, students were not only surveyed on their views of the curriculum, but also on their motivation to enroll in the course and their motivation to work in the course. As shown in Figure 2, students do sign up for Advanced Chemistry because they feel they need it for college. This response, however, was chosen less frequently than other options, such as "I heard it was a good course" and "I really like chemistry." I was intrigued that very few students indicated that they took the course because their parents thought they should take the course.

In terms of what motivates students to work in Advanced Chemistry, students did choose their grade as the number one motivational factor. Other factors were also important to students, however, such as "I really like learning" and "I really like chemistry" (see Figure 3). This is not surprising, as it indicates a combination of extrinsic and intrinsic motivational factors, and it has led me toward a deeper and longer-term inquiry into motivation across the sciences.

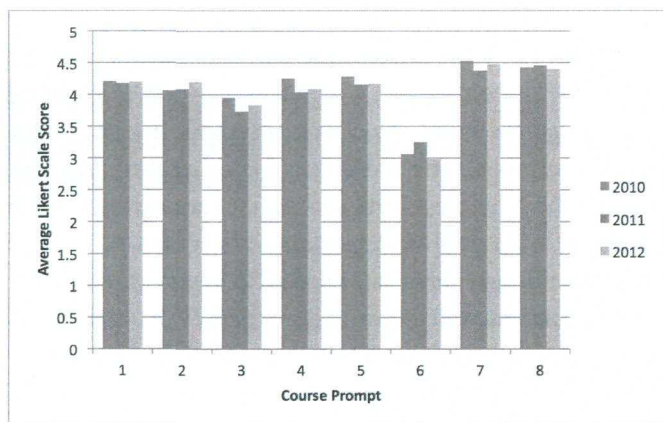
Finally, a couple of observations are important. It is noteworthy that the patterns of student responses over the three years are quite similar, which indicates that it is likely that students' responses are accurately capturing their attitudes towards the course and the sources of motivation for the course. In addition, it is important to note that the survey was not administered to Advanced Chemistry students prior to our implemented curriculum changes, so there is no baseline for comparison. Therefore we cannot determine what student responses would have been prior to curriculum changes. The chemistry team at IMSA does not claim to have created a better course, only a course that is somewhat different than it had been. Advanced Chemistry was a very good course, developed by experienced and excellent faculty, prior to curriculum changes being implemented.

## SUMMARY

Throughout this partnership based on mutual inquiry between our two institutions, much was learned. The difficulties of making curriculum changes that put a greater emphasis on laboratory experiences and less on content are documented in the graduate student's doctoral thesis. I also learned a great deal by reflecting on student responses in the course surveys, and was especially interested in the combination of extrinsic and intrinsic motivational factors that students exhibited and which were quite consistent over a three-year period. That interest has now led to a more scientific approach to studying motivational constructs of IMSA students using a validated research instrument. In essence, the story unfolded like research often does, one set of observations leads to a new set of questions.

IMSA holds a unique place within the state of Illinois, and strives to be a laboratory for teaching and learning. The term laboratory, in this context, does not refer to a chemistry, physics, or biology laboratory. It refers to the academy as a whole, and an attempt to create a constructivist learning environment for students, where learning takes place in context. It refers to an attempt to try new things, to welcome success and learn from mistakes; to take risks. IMSA was indeed the UIUC graduate students', the Ad Chem teacher's, and the IMSA student's laboratory throughout this process.

Figure 1.

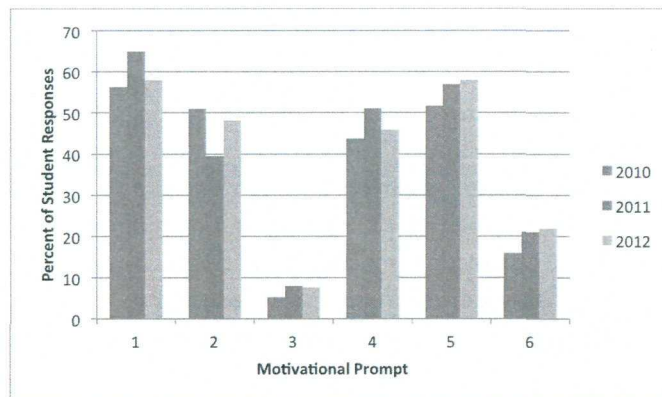


Student responses to survey questions regarding the revised Advanced Chemistry curriculum at IMSA over a three year period (2010-2012). The Likert scale was as follows: 1= not at all; 5=definitely. In 2010, 151 students were surveyed; in

2011, 137 students were surveyed; in 2012, 133 students were surveyed. The survey prompts were as follows:

- 1 – Do you feel Ad Chem is a course that fits IMSA's "philosophy" of learning and teaching?
- 2 – Compared to other IMSA courses, does Ad Chem make you think and analyze concepts and ideas?
- 3 – Have you made connections to other disciplines in Ad Chem?
- 4 – Do you feel you are "constructing" an understanding of chemistry by integrating ideas from lab experiences, the textbook, and classroom discussions?
- 5 – Do you feel that the teacher is providing a classroom environment that helps you "construct" an understanding of chemistry?
- 6 – Do you wish the teacher would explain more?
- 7 – Are the supplemental, teacher-written materials on Moodle helpful?
- 8 – Do you feel Ad Chem is a good IMSA course?

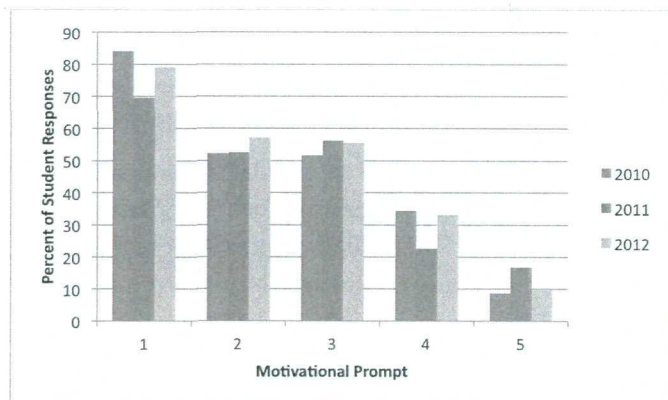
Figure 2.



Student responses to the prompt: What was your motivation to sign up for Ad Chem? (Circle all that apply, fill in other if appropriate). Cumulative percent adds up to greater than 100% because students could choose multiple motivations. Motivational prompts were as follows:

- 1 – Heard it was a good course
- 2 – Felt I needed it for college
- 3 – My parents thought I should take it
- 4 – Everyone seems to take it
- 5 – I really like chemistry
- 6 – Other

**Figure 3.**



Student responses to the prompt: What is your motivation to work at Ad Chem? (Circle all that apply, fill in other if appropriate). Cumulative percent adds up to greater than 100% because students could choose multiple motivations. Motivational prompts were as follows:

- 1 – My grade
- 2 – I really like chemistry
- 3 – I really like learning
- 4 – My parents expect good grades
- 5 – Other

### **ACKNOWLEDGEMENTS:**

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