1. Questions(s) or issue(s) for dialogue at Learning Network Conference session:

How can an integrated program of inquiry-oriented curriculum guides and professional development affect high-school student science achievement in a large school district? What are the difficulties inherent in studying such a situation?

2. Context of the work within the STEM education literature and within your MSP project:

Research has shown and continues to show the many benefits of inquiry-oriented science instruction for student achievement in science at all levels (Handelsman et al., 2004; Anderson, 2002). Inquiry-based instruction is taking hold in many quarters of the science education community (both K-12 and IHE), but it has not been taken up as quickly as some would like. The reasons for this are many, and differ from place to place and teacher to teacher. A common reason, however, is that some instructors and curriculum developers doubt the benefits of non-traditional types of instruction to student achievement, at least for their particular institutional context. It is therefore prudent to continue to study individual cases of implementation and attempted implementation and disseminate the results, so that more nay-sayers might see parallels with their own situations.

The Vertically Integrated Partnerships (VIP) K-16 project is a targeted MSP that is just officially ending. Directed by the University System of Maryland (USM) office, the project is a partnership of Montgomery County Public Schools (MCPS), Montgomery College, and five USM institutions (including research and comprehensive universities and research institutes). The goals of the grant are to provide professional development for MCPS teachers of high school science, to improve MCPS student achievement on the Maryland High School Assessments, to improve undergraduate science education, and to encourage more undergraduate and graduate science students to enter teaching. The primary strategy throughout these interventions is the use of learning communities that focus on inquiry instruction in science. Over the 5 years of the grant, the VIP K-16 project has provided science content professional development for 350 teachers in the form of workshops, seminars, an online community, and a summer institute that focuses on the teaching and learning of science. At the same time, faculty and the Montgomery County science teachers (of 5 different core science courses) have been engaged in field testing and validation of dozens of new curriculum guides and assessments that are aligned with state and national science standards. In addition to the work on curriculum development and assessment, a number of different high school and university partnership activities have been
developed, including internships for undergraduate science majors in high school science classrooms, summer internships for high school teachers in science research labs, and teacher/faculty learning communities that have produced extensive revisions of dozens of undergraduate science courses.

The VIP partnership has resulted in stronger inter-institutional ties that have already formed the basis for new collaboration. In particular, the USM STEM Initiative has grown largely out of the work of the VIP grant. At several partner institutions, as well, a legacy of K-16 partnership and focus on teacher learning communities has blossomed. To name just a few of these sustained reforms: Inquiry-oriented curriculum guides are now in place in all MCPS high schools, a new science building at Montgomery College is being designed to facilitate active learning instruction, and a TA-training program has been implemented at the University of Maryland, Baltimore County.

The largest project associated with the VIP K-16 grant was the planning, writing, and implementation of new curriculum in all five core science courses: Biology, Earth Space Systems, Matter & Energy, Chemistry, and Physics; and the concurrent professional development workshops for all teachers of these classes, designed to make use of these new curriculum guides as they were produced and refined. Associated with the launch of new curriculum materials were new semester exams. MCPS is one of the largest school districts in the country, with about 140,000 students (K-12) and about 450 high-school science teachers.

The curriculum guides and associated professional development centered on a guided-inquiry approach to science instruction. In particular, most of the guides outline a “5 E’s” structure that the teacher can follow for a particular unit: Engage, Explore, Explain, Extend, and Evaluate. Significant attention was paid to examples of lesson plans that teachers might use to teach a particular concept or skill.

In all, 44 curriculum guides were produced and implemented, and 24 professional development days and 4 week-long summer institutes occurred. Those teachers who regularly taught only one of the 5 core courses attended a total of 16 full days of professional development over a two-year period; teachers of more than one course received even more professional development.

3. Claim(s) or hypothesis(es) examined in the work (anticipating that veteran projects will have claims, newer projects will have hypotheses):

Measuring the impact of large-scale professional development on large groups of teachers on their students is difficult, but some influences can be detected. In the case presented here, student achievement seemed to improve slightly in the Fall semesters following the bulk of their teachers’ associated professional development experiences.
4. Evaluation and/or research design, data collection and analysis:

This study examines countywide student achievement data from the core courses and their exams, looking for evidence of professional development effectiveness over the five-year span of the grant.

Final grades and final exam data were obtained from MCPS covering a large portion of the grant period. Although using course grade data as measures of achievement has been shown to be problematic in the literature, we attempted to ameliorate this issue somewhat by triangulating data sources. Common final exam scores for these courses, as well as state High School Assessment scores in Biology, were considered as well. High School Assessments in other science subjects do not yet exist.

Final Biology grade data collection began with the Fall Semester 2002 and ended with the Spring Semester 2009. Grades for Earth Space Systems and Matter & Energy were collected from Fall Semester 2004 through Spring Semester 2009. Finally, Chemistry and Physics final grade data collection began in the Fall of 2005 and ended with the other cohorts in the Spring of 2009. For each semester the following information was provided: total enrollment in each core course, percentage of students earning A, B, C, D, E, and various other grades such as credit/no credit and loss of credit due to excessive unexcused absences. Using the standard quality point scale of A = 4, B = 3, C = 2, D = 1, and E = 0, a grand grade-point average was calculated for each cohort for each semester. Students earning “other” grades were not included in this calculation.

Final exam data in the form of total percent correct were disaggregated first by semester, then by ethnicity, gender, and provision of services. Additionally, subdivided percentages were calculated for science process skills and the various concepts covered in each core course. Exam data were provided for Fall Semester 2004-2007 and for Spring Semester 2006-2008. To ascertain the significance of change in grades from one academic year to the next, changes in mean total grade were calculated for each exam beginning in the Fall of 2005 and in the Spring of 2007. Assuming a central tendency to these grade change data, a mean grade change and standard deviation were calculated for each exam. For the sake of isolating patterns, changes in the total exam grade or in the grade of any sub-category of greater than one standard deviation were flagged for possible further observation, and those greater than two standard deviations were considered to be significant enough to require explanation.

5. Key insights (retrospective for veteran projects, prospective for newer projects) that have value for the Learning Network:

The influence of VIP K-16 grant-related professional development on student achievement as shown by final exam scores and final grades is not obvious because of the number of extraneous variables that could not be accounted for in the analysis. In spite of this, Fall Semester exam scores and final grades in most courses did show signs of improvement in years corresponding to focused professional development given to each teacher cohort (i.e., to teachers of each core course). For example, Chemistry exam scores averaged 68% in the Fall Semesters immediately following chemistry professional development summer programs, but only 63% before the
intervention and 66% afterwards. This trend is especially true of test scores on science process skills. English language learners and to a lesser extent special needs students benefited somewhat from the professional development extended to teachers in those areas throughout the grant cycle. By contrast, Spring Semester exam scores and final grades did not show any detectable influence of professional development.

Interestingly, these results may indicate that effects of professional development are most pronounced (or discernible) only quite soon after the PD experience occurs, and then dissipates some months later. This possibility runs counter to the commonly heard notion that it takes time for substantial changes in teaching practice to take shape after the teachers learn new methods or encounter new curricula, but it fits with the also commonly held idea that teachers need ongoing support in order to successfully implement changes in their teaching.

Specifically, what were some of the factors that may have obscured the benefits of grant-sponsored professional development?

1. Some changes in curriculum were so pervasive that teachers did not adjust immediately to the new guides. This was the case with Earth Space Systems, a complete departure from the “traditional” way Earth Science was taught. It was also true of Matter & Energy, a course whose curriculum guides were not completed until well after the focused cohort training had ended.

2. A number of high school science departments were migrating to a “physics first” sequence. This had two effects. First, more ninth graders were taking Physics, and many of them were struggling with the quantitative concepts of the subject. Second, offering physics to freshmen pulled more able students from Matter & Energy. The result was that the demographics and academic composition of both Physics and Matter & Energy changed during the grant period.

3. High schools made continuing efforts to invite a greater cross-section of students into honors sections of core science courses. The expected outcome is that achievement levels in honors courses slide at least temporarily. Data for Honors Biology, for example, may have been affected by this trend.

There may be no way to filter the effects of these variables on student achievement to isolate the influence of VIP K-16 activities, but even the tentative signals in the “noise” of exam and final grade data is encouraging.

References
