2009–10 STEM Small Grants Program: Improving Instruction and Enhancing Student Success in STEM Disciplines

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Project/Research Title: Collaborative Activities for Science Content Course and Methods Course for Preservice Middle School Science Teachers

Purpose/Background:
Science content knowledge and pedagogical knowledge are dependent on each other to ensure high quality science teaching. Unfortunately, many prospective middle school teachers take science content courses, science methods courses, and general middle school methods courses (including classroom practicum experiences) whose planning and implementation is largely independent of each other. As a result, prospective teachers may not develop sufficiently synthesized and integrated pedagogical content knowledge and skills – the whole of their teacher education may amount to less than the sum of its parts. The purpose of this proposed project is to more effectively develop strategies whereby faculty and teaching assistants from these various settings can more systematically, productively, and consistently collaborate to shape more uniquely valuable experiences for prospective middle school science teachers.

Description of Research Project:
In Fall 2009 Dr. Jackson and Dr Shen are collaborating on the content course [CHEM1060, 18 students] and the methods course [ESCI4430, 19 students] for middle grade science teachers. The content course covers Newtonian mechanics, heat and temperature, electricity and magnetism, and optics, and emphasizing students inquiry and modeling skills. The methods course uses classroom, laboratory, and field experiences to develop a range of strategies appropriate for use with middle grades physical science classrooms. In collaboration, they attended each other’s class and exchanged ideas on how to improve both courses and the coordination between the two.

In Spring 2010 we are observing and interviewing our students from Spring 2009 who are currently student teaching. With the graduate assistants (Julianne Kent and Stacey Britton, doctoral students from the science education program), we have compiled a list of 11 student teachers for each of the four of us to visit, grouped primarily according to our varying scientific and/or grade level expertise and experience (although a minor consideration was efficiency in travel based on geography and existing field supervision assignments in connection with their other assistantship duties). We have observed these students’ science classrooms, conducted “debriefing” interviews with the student teachers (former students), and interviewed two of the cooperating teachers who happen to be alumni of Dr. Jackson’s course from several years ago.

In working with current students in Dr. Jackson’s ESCI methods course, most of whom are also in Dr. Raymond Freeman-Lynde’s Earth Science for Middle School Teachers course, Drs. Jackson and Freeman-Lynde are working together and with the Teaching Assistant for ESCI 4430, former middle school teacher Seri Chapman Beall, to experiment with incorporating more frequent and extensive interactive discussions the Geology course’s lectures, which also serve a function as formative assessments,
modeling an important middle grades teaching technique used successfully by Ms. Beall. These take the form of the periodic inclusion of “Science Conceptest” slides in Dr. Freeman-Lynde’s prepared PowerPoint-based lectures. These are not just “factual recall” types of review questions, but application-level “thought experiments” that require creative and logical thought about factual and conceptual material presented in the preceding 10-15-minute segment of the Geology lecture. Some of the sample, “classic,” hands-on middle grades Earth Science activities, plus a few others, formerly experienced in ESCI 4430 are also planned to be incorporated into GEOL 4750/6750 class time instead during the current and future semesters, because Dr. Freeman-Lynde has grown to appreciate their value in the education of his own college students, not just of their future middle school charges. These include, for instance: physical scale modeling of the solar system and the Geologic time scale via hallway and schoolyard activities; outdoor “shadow-stick astronomy” activities for modeling the Earth-moon-sun system and accurately measuring the observable effects of their interactions with low-tech materials; simulation of the process and logic of radioactive decay and radiometric dating techniques using everyday materials; selected video case studies in the history of science, which have proven to be of high interest and therefore of motivational value for this student population, as a supplement to the customary more detailed (but dry) presentation of historical material in Geology.

Data Collection and Analysis:
For Fall 2009, we have videotaped selected classes of the content course. Students’ artifacts (e.g., assessments for both courses) were also collected. Informal interviews, fieldnotes, and observations are being collected for this Spring 2010 semester, primarily in student teaching settings in middle schools but also in the current Science Education and Geology classes.
Two master theses were conducted on the collaborative effort between Dr Shen and Dr Jackson. One thesis by Lauren McCall investigates the effect of scaffolding in inquiry-based approaches in teaching physics. The other by Rutchelle Enriquez focuses on the impact of modeling-based inquiry unit on preservice science teachers’ conceptual understanding in physics.

Findings
In terms of students’ content preparation, students improved significantly comparing their performances on pretest and posttest. We found that most of our students were engaged in the activities designed to enhance their physics knowledge. Students’ preparation in math (e.g., trigonometry, proportional reasoning, solving algebraic equations) before they entered the Physics course was inadequate and this posed problems with some of Dr. Shen’s designed activities and assessments. Revisions and improvement on these activities will be carefully considered and enacted.

In terms of student teaching, overall, our students are adapting well. They were able to conduct inquiry-based activities with middle school students and to articulate very clearly their thinking processes that led them to make many such instructional decisions. On the other hand, our students expressed several concerns when they are doing their student teaching: e.g., classroom management, content background in Life Science, difficulty in transferring some aspects of what they have learned to a school class, views
inconsistent with those of their mentor teachers. These are important insights that we are going to incorporate in our future teaching.

One finding that is of interest but about which implications for program improvement are not clear is in the areas of curriculum standards and of assessment practices. Both current student teachers and one of the cooperating teachers state that they greatly value the instruction and experiences gained in the methods courses about making independent decisions about the detailed scope and sequence of the curriculum, about writing high-quality traditional assessment items, and, above all, about ensuring that these two correlate highly with each other. In the case of one of the cooperating teachers, however, district policies effectively prevent the exercise of individual teacher judgment in these areas, and nearly all of the student teachers interviewed feel that they are largely deprived of power in making such decisions by their cooperating teachers, leading to both general frustration and a decreased immediately level of relevance of methods course activities to the immediate challenges faced in the student teaching setting.

Conclusions/Recommendations

We believe that our project has resulted in a promising partnership between science and methods courses. We revealed ways to improve and enhance the collaborative effort between content course and methods course in preparing middle grade science teachers. We visited and received feedback from students who do student teaching in real classrooms. We plan to continue the project in the coming year. We believe the continuation of the project will result in improved collaboration effort between the content courses and the methods courses, and enhance our understanding of preparing middle grade science teachers in general.

Dissemination

The team will submit a proposal to present at the 2011 annual conference of the national Association of the Science Teacher Education. The presentation will describe the overall collaborating effort to prepare preservice middle grade science teachers through integrating content and methods courses.

Dr Shen and Rutchelle Enriquez will present at the International Conference of the Learning Science on a unit on electric current implemented in Fall 2009 (Chicago, June 29-July 2, 2010).