Development of Professional Learning Communities: Factors within the NSF GK-12 Program

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Abstract:
This paper focuses on the process and activities supporting professional development for scientist-fellows and teachers in high school classroom environs. The GK-12 Program at UIUC has made it its goal to create a professional learning community where the fellows experience teaching roles from high school mentor/teacher experts; a teaming that often produces a shared vision of comprehensive, coherent, and integrated approaches to professional development and life-long learning. In turn, the teachers themselves mature, developing enhanced content mastery and team-work skills. Our efforts reflect a systematic effort to develop strategies to remedy the present disconnect between teacher preparation and teaching practice by addressing critical issues and needs surrounding preparation, enhancement, and retention of science, technology, and mathematics (STM) teachers for grades K-12.

The GK-12 Program and its research sites:

The National Science Foundation Graduate Teaching Fellows in K-12 Education (GK-12) Program supports teaching fellowships for graduate students in the sciences, mathematics, engineering, and technology (SMET) disciplines. The GK-12 Program is a collaboration of three campuses: University of Illinois at Urbana-Champaign (UIUC, which is the lead institution), University of Alabama at Birmingham (UAB), and University of Alabama at Huntsville (UAH) (http://gk12.ncsa.uiuc.edu). The graduate students collaborate with SMET and education faculty and participating K-12 teachers to integrate the use of computer-based modeling and scientific visualization in science and mathematics education. Responsibilities of these graduate students include visiting classrooms to observe, offering assistance to the collaborating teachers, and co-teaching courses with these teachers, as well as participating in program-related meetings and training sessions. Responsibilities of the faculty include mentoring the graduate students and the participating teachers.

The goals of this GK-12 program include the following: (Jakobsson & Braatz, 2000):

- Develop sustainable partnerships among SMET faculty, education faculty, and school districts through the participation of graduate students with math and science domain expertise.
- Provide professional development opportunities for participating teachers and education faculty related to computer-based modeling, scientific visualization, and informatics.
- Provide professional growth opportunities for aspiring scientists, mathematicians, and engineers, especially encouraging them to concern themselves with education at all levels.
- Integrate computer-based modeling, scientific visualization, and informatics in K-12 classrooms.

The GK-12 program in the first (2001-2002) and second (2002-2003) years at UIUC involved three public high schools and one vocational education school, and three public high schools in year three (2003-2004). These schools were in four geographically distributed cities in Illinois. Six GK-12 teams were placed in six classrooms within these settings. Each GK-12 team is comprised of a graduate fellow, a teacher, a university mentor, and an evaluator. The graduate fellows who are scientists-in-training and their collaborating teachers, however, make the core of each GK-12 program team. The graduate fellows (3 women, 3 men in years one and two; 4 women, 2 men in year three) in the first year at Illinois included a computer scientist teaching calculus in a high school classroom, a mathematician teaching college algebra in a vocational classroom, a molecular biologist teaching bioinformatics in an advanced placement high school biology classroom, another molecular biology fellow teaching bioinformatics in a freshman high school honors biology classroom, a chemist teaching molecular visualization in high school biology and chemistry classrooms, and an information scientist with a mechanical engineering background teaching heating, ventilation, air conditioning and repair in a vocational classroom. Year two, the program added a computer scientist working with a regular biology teacher and an environmental scientist working with both biology and chemistry classrooms. Two fellows graduated, earning positions in educational institutions. We are now in year three (2003-2004), and have added two computer science fellows: one in regular physics and chemistry-physics classes and another in an advanced computer science elective; one entomologist fellow partnered with regular and honors chemistry classes; and one social science fellow partnered with regular history classes.

Science and Teaching: Tandem Actions

It has been argued that learning to teach is best regarded as a continuum of programs and professional experiences (Bransford, Brown, & Cocking, 1999; National Research Council, 2000; Wilson, Floden, & Ferrini-Mundy, 2001). This teacher professional continuum begins with a teacher's K-12 experiences and continues with teacher preparation programs, instructional practice, professional development, leadership development, and other life and professional experiences. In particular, teacher preparation and professional development should be viewed as different parts of the same, complex, life-long learning process. In reality, however, teacher preparation programs and professional development experiences are too often disjointed and, even worse, disconnected from classroom practice (Garet, Porter, DeSimone, Birman, & Yoon, 2001; Goodlad, 1990). This disconnect adversely impacts the teaching and learning in all subjects, of course; but is particularly apparent in K-12 science, technology, and mathematics (STM). According to the report from The National Commission on Mathematics and Science Teaching for the 21st Century (2000), entitled *Before It's Too late*, U.S. students are receiving only a superficial knowledge in today's classrooms. The report states: "In an age now driven by the relentless necessity of scientific and technological advance, the preparation our students receive in mathematics and science is, in a word, unacceptable. Despite our good intentions, their learning is too often superficial. Students' grasp of science as a process of discovery, and of mathematics as the language of scientific reasoning is often formulaic, fragile, or absent altogether" (p. 10).

The report notes that the problem with current science education is that students are not required to master "big concepts that make science so powerful and fascinating" (The National Commission on Mathematics and Science Teaching for the 21st Century 2000). Training the teacher to teach "good science" may not be the issue; rather, it may be we need to train our teachers to *learn* "good science" and scientists to learn "good *teaching*." This is what GK-12 largely is established to do.

One of the primary goals of the GK-12 Fellows program has been to mend the rifts between education theory and practice; between science and technology education and "real-world" scientists and practitioners. Why? Because focusing on bridging these gaps promotes quality STM teaching and learning. Improving the quality of STM teaching and learning in U.S. schools clearly requires a significant investment in the K-12 teaching workforce and its supporting infrastructure. It demands administrative support, flexibility, and inter- and intra-departmental teamwork at both the university and K-12 levels. It demands training and sustained support in technology tools that take into account androgogy as well as pedagogy, honoring the learner at all points in the learning continuum. After two and one-half years of data in the field; after countless site visits, interviews, surveys, and observations, we—with some degree of confidence—are suggesting a model of collaborative teaming that promotes a culture of authentic professional development. The GK-12 program aims to support the needs of STM teachers, and data thus far reveal the contributions and the challenges we face in making a difference. Our findings have allowed us an opportunity to identify factors that support success, while also identifying factors that contribute to less than quality teaching and learning.

McLaughlin and Talbert (1993) found that when teachers were brought together for collaboration, they developed a body of knowledge and wisdom related to learning (as cited in Harnisch and Shope, 2003). What are termed "Professional Learning Communities," (PLCs) are built on shared goals and values; facilitate communication and collaboration about teaching and learning; and offer some means to assess the progress that is being made (Dufour and Baker, 1998). Professional Learning Communities empower teachers to better focus their planning and teaching, develop a common curriculum and better assessments, isolate areas of the curriculum that are not performing well, and motivate teachers to continually improve in their own professional development. (Dufour and Baker, 1998, p. 176-178; as cited in Harnisch and Shope.) There are certain convergences between PLCs as defined here, and the data we are analyzing within the context of the GK-12 Program.

Factors of Success:

Based upon data thus far gathered, we are seeing certain models of success emerge. These models include the following factors: (1) commitment to excellence on the part of the fellow, the teacher, and the institutions involved; (2) role of collaboration seen as valuable and worth investment of resources on the parts of the fellow and teacher as well as the institutions to which they belong; (3) community building as a guiding ethos as indicated by sharing their experiences both within the K-12 schools with colleagues and taking part in national dialogues on STM (e.g., presentations at NSTA, problem-based learning workshops, etc.); (4) active pursuit of meaningful technology integration, where both the fellow and the teacher become willing to expand their own understandings of technology use in the classroom and even challenge the status quo at administrative and board levels; and (5) facilitation of inquiry- and problem-based learning in a climate where accountability and data-driven decision making has become dominant; and making the commitment to maintain flexibility, patience, dedication, curiosity, and reflection on their own teaching/learning styles.

"Success" as identified above has been reflected throughout these years as based on the level each fellow or teacher felt supported. For instance, the more supported a teacher feels in his/her classroom, and the more collaborative the fellow-teacher team, the more likely inquiry- and/or problem-based learning is employed. Why is this relevant? According to the Center for Science, Mathematics, and Engineering Education at the National Research Council, inquiry-based learning provides a framework in which both abilities and understandings in the sciences can be achieved (National Research Council, 2000). It is the responsibility of our professional development cultures to identify just what factors best support inquiry-based learning in order to achieve.

Success rests, ultimately, in creating environments where the student, teacher, fellow-scientist, and administrators partner to maximize potentials.

Continuing Challenges:

"Frustration," is a word we have observed in journals and surveys by both the scientist fellows and teachers in the data. The word is used in different contexts; however, it mirrors certain themes. For instance, fellows have expressed frustration with their academic mentors who seemed dismissive of the fellows' needs for guidance and support during their GK-12 years. Indeed, while the academic faculty-mentors voiced overall interest and commitment to the program, only three faculty-mentors over these three years have demonstrated to "their" fellows any sustained active engagement or professional support as the fellows struggled to mature professionally in these dual worlds of science and education. Negotiation of these two often disparate spheres created tensions; if not overt, at least in the minds of the fellows who expressed feeling "left on my own." Curiously, it is this vacuum that some K-12 classroom teacher/partners began to fill, and which—ultimately—contributed to successful collaborative teams. However, if the teacher did not choose to take on this role, teaming—at least as indicated by our data—did not successfully occur.

"Frustration," as expressed by teachers mirrored the fellows, in some degree: administrators or department heads sometimes were perceived by the K-12 teachers as unaware of the time and effort required in participating in the GK-12 Program. The demands upon the K-12 teachers were not uniformly accommodated: time for planning, technology support and training for remote teleconferencing, and computer tools in the classroom for the students' hands-on experiences, were all viewed as challenges by different teachers across the state. A frustration voiced in unison was the pressure to "teach to the test" and not being allowed the authority to engage in authentic teaching/learning experiences in the classroom (e.g., time to use to best advantage the fellows' expertise). Indeed, one fellow-teacher team mutually agreed to conclude their relationship at the end of one year because the two science teachers could not utilize the considerable talents of the fellow due, in no small part, to a newly adopted approach taken by the school under pressure of the No Child Left Behind Act.

These challenges are further evidence that professional development in teaching/learning cultures at *all levels of education* need support. In order for PLCs to develop, we must meet and overcome these obstacles at the institutional and infrastructure levels.

Conclusion:

Solutions to the challenges we—as a community of educators invested in professional teacher education—face rely on a key skill: communication. For creative innovation to occur, attention to primary role players must be paid. "Inattention to communication is a *leading cause of the failure of change efforts*" (Dufour and Baker 1998, p. 129)" (emphasis added). For sustainable change to occur, we need to listen to the voices of the teachers, students, administrators, and faculties of our learning institutions who are expressing frustration with the current infrastructure in STM education.

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