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Partners in Time—Strategies for Establishing an Effective Partnership between the University and the K12 Community

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Abstract

Today's funding environment makes it imperative for institutions of higher education to actively solicit and maintain a positive ongoing relationship with the K12 community. Government and private dollars are often offered with the caveat that the universities engage local school districts in some part of the efforts. The K12 community, while under constant budget pressure itself, and therefore welcoming of additional resources, faces high stakes testing and accountability demands, teacher shortages and a myriad of other issues that might make starting, or maintaining, a relationship with the university less attractive.

The key to establishing a symbiotic, long term relationship with interaction at all levels is forming programs that benefit both constituencies in a way that is not perceived to add to current workload. From the university's standpoint, obtaining the funding to complete its primary task, usually research, is the key driver. In the K12 community, it is incorporating new programs and ideas in a manner sensitive to the district's current climate and workload. The College of Engineering (COE) at North Carolina State University (NCSU) has, over the past five years, developed such a relationship with the local Wake County Public School System (WCPSS). WCPSS is the 25th largest school system in the country, with 127 schools and over 108,000 students. Engineering faculty and staff are actively involved in all grade levels and have developed a trusting, productive working relationship with WCPSS central office personnel. The result of this relationship is the university has a willing partner when seeking funding for research and growth opportunities, and the school system has a responsible collaborator on its initiatives. The end result is that this partnership is a winning proposition for the full K16 community.

The Importance of the University-K12 Partnership

The need to establish a symbiotic relationship between these two entities is apparent. In today's economy, funding agencies are especially concerned with the 'bang for the buck' for their investment dollars. Increasing the spectrum of the population benefiting from this investment makes both economic and public relations sense. Science, technical and engineering pipelines at universities are under constant recruiting pressure, challenging enough for the general population but especially so for under-represented groups and women in these fields of study. In addition, universities have a vested interest in the rigor of the K12 curriculum so that incoming freshmen are well prepared for the demands of collegiate academics.

Universities and K12 institutions share the burden of adequate preparation for students who may choose technical careers. Indeed, universities "have a crucial role to play in the important strides being made to transform K12 science and math education."[1] Weaknesses in the preparation of K12 students in science and mathematics are well recognized. The academic performance of U.S. students in mathematics and science slips from near the top of the list of 48 countries at the elementary level to near the bottom during the high school years (National Center for Education Statistics, 1999a) Since learning of science and mathematics tends to be hierarchical, the ability of students to take advanced programs in these subjects (as in AP or IB high school classes or a post-secondary engineering program) is highly dependent on the earlier years of schooling.[2] This results in constraint of the pool of qualified high school graduates who can successfully complete the rigorous course of study for a science or engineering profession. This academic underachievement will only improve with sustained and intensive effort—and standards and testing movements have put efforts to increase achievement in the spotlight. But testing alone will not achieve the goal. Technical professional organizations recommend "a reexamination and strengthening of the U.S. public education system through a focus on higher academic standards."[3] Overall, it is fair to say that higher academic achievement for more students is critical to enlarging the pool from which universities can draw.[4]

At the local level, the COE at North Carolina State University has the same concern. Recruitment and retention of a qualified, diverse student population are ongoing focus areas. For example, enrollment of women in State's engineering program has dropped from a high of 23% in 1997 to a low of 16% in 2003. Minority representation is equally challenging. In the fall of 2003, African-American students comprised 7%, Hispanic students 2.5% and Native American students less than 1% of the total students enrolled in the COE (NCSU Institutional Planning and Analysis, 2004). And yet, NC State College of Engineering is among the top ten universities in enrollment of these underrepresented groups. From a preparation standpoint, students themselves (men and women) report having difficulty adjusting to the academic rigor of the coursework, citing particular struggles with the expectations for computer literacy and ability.[5] At the same time, the Wake County Public School System has taken unprecedented steps toward high achievement for all by setting an ambitious system wide goal of 95% of students in grades 3-12 performing at or above grade level in reading, math and science by the year 2008. An achievement gap between white students and African-American, Hispanic and low-income students persists. A state mandated testing and accountability program augments the demands of federal No Child Left Behind legislation. The culmination of these shared concerns is the need for a real, dynamic and symbiotic partnership in which resources are utilized and leveraged to the benefit of the entire K16 community.

NCSU College of Engineering and Wake County Schools: A Partnership Grows

The deep and mutually beneficial partnership now enjoyed by NCSU COE and WCPSS began very simply. Although the college had previously worked with individual schools on occasion, providing technical expertise or outreach services, the relationship was largely dependent on the individual faculty members involved. Then two coinciding events occurred that were the impetus for the current partnership. First, the COE created a position of Director of Outreach and Women in Engineering (WIE). Then, this director was named one of the principal investigators on a new kind of National Science Foundation grant, the GK12 (Graduate Fellows

in K12 Education). This program's overall intent was to build on and strengthen the bond between universities and the K12 community.

NCSU's specific goals for its program were as follows:

- To integrate science, technology and engineering topics with math, reading and writing in the K12 classroom
- To encourage underrepresented groups in science, technology, engineering and math (STEM) through role models and particular teaching techniques
- To teach STEM content to diverse populations, including hearing-impaired students, students for whom English is a second language, students identified as being low income, and others
- To adapt STEM content to appeal to different learning styles

To facilitate the program's implementation, the director hired a longtime collaborator, herself a mechanical engineer, as the program manager.

Both women are parents of school-aged children, and were already well-established volunteers at their children's respective schools. As engineers, their ease with math and science concepts and the integration of those two subjects into other core academic subjects was appreciated and well utilized by much of the school's staff. In addition, both had taken on additional volunteer responsibilities working with school system central office personnel and the school board, participating in advisory councils, board committees and task forces. Therefore, when the NSF award was made, the relationships that had developed between the PI and program manager and school administrators, instructional resource teachers and classroom teachers was instrumental in the development and execution of the grant's implementation plan. Mutual trust and understanding was a given, and their previous work helping teachers to implement the North Carolina Standard Course of Study (NCSCOS) in science and math helped greatly to facilitate effective use of both the university students' and the classroom teachers' time and expertise.

The grant's model is straightforward: graduate and undergraduate engineering students are paired with elementary or middle school classroom teachers to co-develop and deliver inquiry based lesson plans in science and math, or through integration of those subjects into a language arts or social studies unit. Fellows were expected to spend approximately 10 hours per week at the school, plus an additional five hours planning, attending meetings and documenting their work. Over the four years of the grant, 21 fellows worked in approximately 60 classrooms, impacting over 2000 children and over 75 teachers in grades K-8. From the beginning, the project directors were sensitive to the need to promote technical ability and enjoyment through the hiring of a diverse group of students. The breakdown of the fellows' gender/ethnicity follows.

White Female	White Male	Black Female	Black Male	Hispanic Female	Hispanic Male
9	4	3	2	2	1

In addition, one fellow was proficient in American Sign Language and worked with the hearing-impaired teacher and students to develop signs for scientific terms. Four of the fellows were multi-lingual, and thus were able to bridge gaps with students in the program that were limited in English proficiency. The impact of these role models was significant. Students were exposed to female engineers more than 2/3 of the time. The project directors, both female, were very frequent participants in the classroom. At one point, a third grade boy asked the PI, "Do you have to be a girl to be an engineer?" The positive effect of role models is particularly profound for girls, who often begin to drop off the advanced math path in late elementary or middle school. According to the Advocates for Women in Science, Engineering and Mathematics, "the most successful efforts to support girls in the sciences begin in elementary school…study after study has pointed to the presence of positive female role models in the sciences as being the single most important factor in sustaining girls' interest in the sciences." [6] The program's own assessment corroborated this statement; pre-and post survey results indicated that girls in grades 3-5 experienced the greatest increase in their positive feelings about science.[7] In addition, the same positive role model impacts for students from underrepresented groups, particularly black males, was reported anecdotally by teachers, parents and students.

Over the same four years and far beyond the scope of the GK12 grant, the College of Engineering has increased the level of involvement in the school system in a variety of ways. Representatives from the COE were part of a team of administrators, teachers and parents who took part in the American Physical Society's Lead Scientist Institute, a five day seminar on the best practices in reforming traditional science instruction. Together with WCPSS central office personnel, they have formed and chaired a committee of citizens intent upon adopting inquiry based science instruction across the district. The committee is a broad based group consisting of representatives from local industry, NCSU and other local colleges, WCPSS central office and building personnel, the North Carolina Department of Public Instruction and parent groups. In the past two years, this group has developed funding proposals and plans for collaborating on full implementation K16.

Additional effort has been spent to help teachers relate engineering problem solving methods to the goals and objectives they are held accountable for in the NCSCOS. This practical application of concepts taught in class helps teachers to appeal to a broader range of learning styles in their classroom.[8] Traditional university interactions have also been utilized, including campus tours, summer engineering camps, after school engineering clubs and participation of high school students in the college's Freshman Design Day competition. COE personnel co-taught an Introduction to Engineering course at a local urban high school in Fall, 2003 regularly accompanied and assisted by NCSU freshmen women scientists and engineers who live in the Women in Science and Engineering (WISE) Living and Learning Community. This was an ideal opportunity to reinforce the undergraduates' view of themselves as scientists and engineers, hopefully to result in a higher retention rate of these women.

The guiding principle used by both school system personnel and COE partners is that each brings a viable, respected and desired professional expertise to the relationship. To that end, COE staff ensures that teachers are well compensated for their time and effort on joint projects. When

collaborating on the college's middle school engineering summer camp, for example, teachers are paid in two weeks what many might earn in two months of summer moonlighting. This ensures that the best teachers remain available for the camp because it is financially viable for them. The planning and implementation of that camp is a true division of labor between the COE and the teachers. COE faculty propose activities for each of the engineering disciplines being explored, and teachers tie the activity to the goals and objectives they teach. The entire team tries every activity, engineers seeking technical accuracy and teachers weighing in on whether the activity meets the content goals and is appropriate for the targeted grade levels. The planning week of the camp is spent on the university campus, allowing the teachers a view into the engineering school. Laboratory tours and presentations of leading edge research projects are part of the agenda. The camp itself is held at a middle school, and while co-taught by both the engineers and the educators, it is the teacher team that has ultimate control.[9] This approach is fundamental to one of the camp's goals to provide the teachers with realistic, cost effective, and tested demonstrations, activities and ideas as well as the content knowledge they need to reinforce the concepts they are already teaching. The experience would be largely ineffective if the teacher were not able to implement the lessons in his/her own classroom.

Best Practices in Establishing Effective Partnerships

The National Science Foundation's GK12 program is a good example of an effective partnership builder. The goals of the program focus on the education continuum K16 and recognize, and indeed rely on, the fact that both the K12 institutions and those of higher learning are dependent on each other to maximize benefits and results. Universities, through the program, get graduate students who are better teachers, and potential future faculty. The K12 teacher deepens his/her content knowledge in STEM subjects, and develops an expertise is integrating these topics across curriculum. K12 students benefit by both the positive role model and interaction of the university student and from the teacher's increased comfort level in STEM subjects.

Other best practices abound. At Iowa State University, a K12 Engineering Educational Outreach Center was established to address curriculum and pipeline issues. Recognizing that "teachers working with a base knowledge of engineering can naturally encourage students to consider engineering as an interesting area to explore" [10], the center's founders acknowledge the dependence on teachers for increasing the pool of qualified university students in technical fields. Tufts University was instrumental in the state of Massachusetts' adoption of engineering standards for K12 students and its Center for Engineering Educational Outreach is deeply entrenched in the effort to work with the K12 community to develop curricula to support this set of standards.[11] Duke University, through the efforts of Dr. Gary Ybarra, has developed significant partnerships with local K12 school districts through collaboration on teaching fellow and math curriculum grants and a math/science partnership.[12] In the Commonwealth of Virginia, K12 students are expected to not only learn about engineering design as an activity unto itself, but to engage in design projects of increasing complexity over time.[13] State universities play a large part in implementing this concept. Throughout the country, progressive engineering universities have realized the commonalities between their own goals and those of the K12 community.

Developing a Framework for a Successful Partnership

The first step to developing a productive partnership is to seek out those with a vested interest in the outcome. Some parents and other volunteers--who may also be faculty members at the university--have an established track record with individual schools, which is a strong foundation for collaboration. Once a relationship is established at a particular school, the potential for growth both upward and downward is much easier. For example, if a university professor or department is concentrating on math tutoring for upper elementary students, it is a natural outgrowth of that work to expand the program to the middle school the elementary feeds into. By the same token, expanding downward to increase math proficiency at an earlier age would be most welcome, since accountability measures put enormous pressure on the school to demonstrate year-to-year growth for every child. A most effective way of initiating such a relationship would be to contact the school principal *and* the person responsible for curriculum integration or instructional resource. School system personnel are very receptive to specific offers of assistance. Specificity goes both ways—universities are often very willing to provide expertise and/or materials to K12 educators if needs are identified clearly—and the university makes it's interests known. Working through parent groups is another possibility. The already established networks of Parent Teacher Associations/Organizations (PTA/PTO) are a direct path into the school's population and its calendar of activities, and to STEM professionals who might be interested in participating in any university effort.

There are a number of activities or offerings that universities may offer to K12 schools that will inspire future collaboration. Most require very little in terms of financial, material or professional resource. Examples include:

- **Hosting a family engineering, science or math night**: School families are invited to participate in a variety of activities designed to increase their knowledge of and comfort level with the subject. University faculty and staff can provide both material resources and professional expertise. Another version of this offering is to host a community STEM event at a local mall, community center or park. Advertising the event through the school system's own communication vehicles is an easy way to get interested educators to participate or attend. The optimal way to begin such an event would be for university personnel to find teacher collaborators and plan together.
- **Providing campus and/or lab tours for middle and high school students and teachers.** Giving exposure to leading edge research and development is an effective way to showcase both the research arm of the university and its commitment to community service. By the same token, the participating students and teachers are introduced to activities at the university that they may not be aware of. The potential results are tremendous, from teachers encouraging students to attend the university to teachers themselves seeking continuing education to the university forming connections and relationships for further outreach/collaboration.
- **Seeking high school students who will participate on university student design teams,** such as Freshman Design Project/Day or senior design project groups.
- **Providing college students to schools for service learning opportunities.** These could range from a single visit each semester or year to do necessary tasks (setting up lab

rooms, media center work, administrative work, assisting in labs or demonstrations, etc) or regular commitments such as tutoring.

- **Providing an 'ask the scientist' service.** Volunteers from the university faculty could serve as an electronic 'answer' box to K12 students with science questions. Again, collaborating directly with teachers can lead to the success of such a program.
- **Seeking opportunities to collaborate professionally with K12 teachers and administrators.** These might include joint presentations at respective professional conferences, designing summer and/or after school offerings that combine engineering with other core subject areas, and seeking outside funding to further the work of both institutions.
- **Providing university faculty, staff and students to local schools** for science fair mentoring and judging, math or science tutoring, 'lunch buddy' programs, etc.
- **Initiating the formation of an after school 'Engineers Club' at a local middle or high school.** The university can provide professors, students and materials to conduct hands-on, collaborative activities that explore the different engineering disciplines. This can be coordinated through a central person, with different departments taking charge of a session.

A key component in the development of a successful long-term partnership is to implement, early in the relationship, staff development training for personnel from both the university and K12 institutions to understand the needs of the other. This is a necessary step to affect the required paradigm shift in university-K12 relationships. A common pitfall in the past has often been the university viewing itself as a 'benevolent benefactor' gracing the K12 community with its efforts. By the same token, K12 educators might be viewed as 'territorial' about their classrooms. These traditional approaches do not allow for either side to understand what drives the other, and have been perceived as demoralizing for K12 educators and off-putting for university faculty.

Both institutions have important issues that drive both their daily and strategic efforts. For example, K12 districts in North Carolina have annual End of Grade Exams in reading and math; an upcoming new End of Grade exam in science, End of Course exams in high school, achievement gap issues, and responsibility to implement the myriad of goals and objectives as dictated by the North Carolina Standard Course of Study, among other things. Universities have research and leading edge concerns, recruitment and retention issues for faculty and students, and confront under prepared students every term. Both sides need to clearly understand what drives the other; so collaborative efforts may be implemented in effective ways for both.

Summary

The need for collaboration and effective partnership is obvious. As Walter Gmelch, dean of the college of education at Iowa State University, observed, "To fulfill their role, schools need teachers who are grounded in science, technology, engineering, and mathematics. This, in turn, calls for effective teacher-training programs, developed jointly by experts in technology and

education. The deans (education and engineering school deans at the Dean's Summit, January 2003) seek to nurture such partnerships on college and university campuses worldwide."[14]

The College of Engineering at North Carolina State University has, in the past five years, developed a mutually beneficial partnership with its local school system, Wake County Public Schools. Using the NSF GK-12 grant as a springboard, the relationship has developed into a broad symbiotic one with both partners working for the good of the K16 continuum, utilizing resources such as funding, materials and expertise. The development of partnerships between K12 institutions and universities is a necessity for the future success of both. Initiating, implementing and maintaining these partnerships will help create the climate of success necessary for all students K16, thereby significantly benefiting both the university and the K12 school system.

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