"We're just trying to improve the quality of STEM education!": The Structures Imposed by University Politics and the Bottom Line

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VEXATION, VENTURE, AND MORE VEXATION

The old adage suggests, "The road to hell is paved with good intentions." I am convinced that, at the very least, well meaning, carefully conceived propositions are determined to lead to frustration and more than a little angst: perhaps a bit of "hell on earth." Such has been the road we are traveling toward developing an integrative Science, Technology, Engineering, and Mathematics (STEM) education masters program.

National reform documents have long called for educators with the content expertise to effectively teach science, technology, and mathematics using methodologies that emphasize real world connections (e.g., *Science for All Americans* [1990], *Principles and Standards for School Mathematics* [2000], *Standards for Technological Literacy* [2000]). The premise is that high quality teaching in mathematics and science requires an integrated understanding of how the disciplines of science, mathematics, and technology together contribute to the development of scientifically literate individuals (AAAS, 1990; NRC, 1996). Thus, the recommendations are for us to implement widespread masters degree programs in STEM education to enhance the education and skills of practicing teachers (National Academy of Sciences [NAS], 2006). These programs are to prepare teachers with the understandings and abilities requisite to teach across STEM disciplines and to implement interdisciplinary approaches that reflect the interdependent nature of STEM-related fields.

An increasing number of graduate programs across the country describe a STEM focus. Typically, these programs fall into three categories: (a) a concentration on developing a greater depth of content knowledge in a single STEM field (*e.g.,* chemistry, mathematics, physics, electrical engineering) as preparation for a variety of employment opportunities or advanced study; (b) an emphasis on a particular STEM education discipline (*e.g.,* mathematics education, science education, technology and engineering education) and offers a mix of discipline-specific research, pedagogy, and content courses; or (c) a focus which is more cross-disciplinary, requiring participants to enroll in a set of core education and research courses and to select a mixed collection of elective courses from a list of STEM-related disciplines across campus (*e.g.,* biology, geology, mathematics). While each of these degree options offers participants significant advanced preparation under the umbrella of STEM, they continue to isolate science, technology, and/or mathematics into discipline-specific "silos"; indeed, they lack explicit integration across the STEM disciplines.

In contrast to these types of programs, we (my colleague, Pam Cantrell, and I) envisioned an *integrative* STEM education graduate experience wherein the required courses (in our case, six courses—18 hours, which would introduce a new STEM Education specialty option to our existing MA in Teacher Education program) would explicitly emphasize the interconnected nature of the STEM disciplines as they function in real world applications. Participants would study the historical and philosophical, theoretical, and pedagogical foundations of STEM education; explore and apply instructional methods and strategies appropriate across disciplines (*e.g.,* inquiry, engineering design cycle); develop and implement integrated STEM curricula; investigate trends and issues in K-12 STEM education; and study contemporary modes of assessment in STEM education and research.

This, then, was our dream…and became our venture. Perhaps a bit naively (in afterthought), we confidently set out to make the dream a reality. We recognized, of course, that designing and enacting a truly integrative experience would require significant time and effort. Yet, how could our objective be questioned or thwarted? After all, we were well intended; we were seeking to improve the quality of STEM education…a worthy goal. Additionally, our research had revealed that there was even a precedent of two existing interdepartmental graduate programs on campus. However, we were not expecting the obstacles introduced by university politics and a "bottom line" strengthened by a period of severe economic downturn.

Our department, the Department of Teacher Education, houses five tenure-line STEM educators (two science educators and three mathematics educators), all of whom qualify as graduate faculty. Although these faculty resources represent sufficient numbers to adequately offer the new STEM focus area, we recognized that developing a strong integrative experience would potentially draw on the strengths of various units across campus in a collaborative way. Thus, significant investment in relationships at various levels would be required. Acknowledging this, we sought to develop an interdisciplinary structure that would lead to a graduate experience of real consequence, one that would best serve the needs of the graduate students and, of course, their students in turn. In short, we set out to discuss possible options and to strengthen relationships within our own

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Department between math and science educators while developing new relationships between individuals in our department and individuals in other departments across campus.

At first, the road we traveled was relatively smooth. Two of the mathematics educators in the department wholeheartedly embraced the vision of an integrative STEM emphasis. Although the third mathematics educator voiced support, her enthusiasm was markedly muted. Five years earlier, she had proposed a mathematics education specialty option for the masters program, which was denied because it would duplicate a program offered by the Mathematics Education Department. Because she cherishes hopes for future adoption of a math emphasis, she now fears approval of the STEM emphasis will only serve to postpone her personal goal. Nevertheless, she agreed to support the current proposal as a more immediate means of introducing mathematics into the graduate program and as a way of supporting her colleagues. Meanwhile, our department Chair and faculty unanimously approved our proposal for the new specialty area. We then employed a "grass roots" strategy, approaching the faculty in the Department of Technology and Engineering Education (TEE), which houses STEM disciplines not represented in our own department or college. They were delighted to collaborate in developing and team-teaching the six STEM courses, even suggesting that they would delete their existing masters program in favor of the more rigorous and timely collaborative project we were suggesting; they were certain their Dean would be supportive. We also communicated with faculty representatives from the Department of Mathematics Education (ME), soliciting their input and participation in the program in a substantial way; they have agreed, initially, to offer feedback on proposed courses and to serve on thesis committees. Additionally, we sought contribution from STEM departments across campus (*e.g.,* Microbiology & Molecular Biology, Geological Sciences, Physics & Astronomy, Chemical Engineering), requesting their support by sharing current advances in their respective fields through a seminar course.

At this point, serious "pot-holes" began to appear along the road. Although supportive of the proposed STEM emphasis in theory, our Dean introduced the first major obstacle: the "bottom line" (resources, current faculty teaching load, university emphasis on undergraduate education), particularly problematic because of the University's current hiring freeze (a response to the severe economic downturn of the past year). If we were engaged in teaching these new graduate courses, who would assume our current teaching responsibilities (primarily undergraduate)? Did we not have enough to do that we were creating more work for ourselves? Surely, we were aware of the hiring freeze and its related constraints? A second obstacle soon surfaced: university politics. Although supportive of sharing the STEM courses, TEE would not give up a degree program in favor of an existing program and new emphasis in Teacher Education, responded their Dean's office. Instead, as we submitted our proposal for the addition of a new STEM specialty focus area to the University Graduate Council for approval, TEE would propose a parallel change. They would request approval of a completely "new" program to replace their existing program—one which would require the six shared courses (cross-listed) and our research courses (12 hours), and would "strongly suggest" our other masters level core courses (12 hours) as "electives". In turn, Graduate Council rejected the proposal from TEE, recognizing the profound overlap between the two programs and suggesting that the university is not anxious to duplicate offerings across campus. At the same time, the council requested that Teacher Education consider how we might approach the STEM courses if we did not collaborate with faculty from TEE. But then, if this is our only option, the dream of an integrative STEM education graduate experience loses an essential and powerful interdisciplinary component.

This is where we find ourselves. After traveling this road for over 12 months, our good intentions and initial venture has led to further vexation. At this point we recognize that we are somewhat limited by circumstances beyond our control. Indeed, my husband councils us to "let it go," and he is generally right. Nevertheless, we still believe that our venture is worth pursuing, our department faculty remains supportive, and our faculty counterparts in TEE urge us to continue to work together to accomplish our shared objectives. At least within these groups it seems that we have developed relationships that may facilitate further action toward our ultimate goal (Coleman, 1988). Amongst these individuals, certain values are now shared (Field, 2003) and a level of trust and a sense of obligation to each other now exists (Dika & Singh, 2002). So, where do we go from here? Is this a program that should be pursued further? If so, what other relationships might be developed or strengthened in order to pave the way? What information channels (Dika & Singh, 2002) might be created or further developed; how might we build the social capital necessary?