Dual Appointments in Science and Mathematics Education: Supporting Collaboration for Education in a Democracy

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Abstract

Over 15 years ago, Wright State University in Dayton, Ohio, began a long-term commitment to improving teacher preparation through dual appointments in science and mathematics education between the disciplinary departments in the College of Science and Mathematics and the Department of Teacher Education in the College of Education and Human Services. These appointments were envisioned within the philosophical framework of the National Network for Educational Renewal and enacted to develop teachers who can foster the skills, dispositions, and knowledge necessary for effective participation in a democracy. The evolution and outcomes of these appointments are shared as a model to expand collaborative educational renewal in a democracy.

Dual appointments have long been suggested and debated as a means to improve teacher education and undergraduate education. Dual appointments between colleges of arts & sciences and education can integrate their respective knowledge bases, practices, and cultures in order to provide deep content and content-specific pedagogical learning experiences for teachers. Dual appointments can also serve as bridges between the different stakeholders in teacher education institutionally and in P-12. However, without institutional, college, and departmental commitment and support coupled with clear performance expectations, these positions can easily fail.

In 1995, about the time of Wright State University's (WSU's) first dual appointments, the cultural and conceptual rift between colleges of arts & sciences and education was being cited as a barrier to improving teacher education, particularly in the sciences and mathematics (Advisory Committee to the National Science Foundation, 1996; Caprio, 2001; Hutchings, 2000). Pedagogical research was not accepted as legitimate research in most science or mathematics departments. Specialized content courses for future teachers, particularly at the elementary levels, were rare. The national science and mathematics standards had just been released. The discontinuity in science and mathematics teaching with respect to both content and practice had been a pervasive problem in teacher education for decades (Atwood, 1973; Newton & Watson, 1968). At that time, reform in mathematics and science teacher preparation often occurred through changes in isolated components of programs, rather than to the entire program (Anderson & Mitchener, 1994).

Philosophical and Conceptual Grounding of Dual Appointments

The concept of dual appointments at WSU is grounded in the philosophies of John Goodlad and the National Network for Educational Renewal (NNER) that encourage collaboration among multiple stakeholders for the simultaneous renewal of P-12 schools and teacher education (Goodlad, 1990). One of the central goals of the NNER's Agenda for Education in a Democracy is fostering the skills, dispositions, and knowledge necessary for effective civic par-

ticipation in our social and political democracy (Goodlad, Mantle-Bromley, & Goodlad, 2004). The public's understanding of science, mathematics, and technology issues is critical to civic engagement and the functioning of modern democratic societies. A new challenge for science education emerged: "Can we shift our goals, programs, and practices from an overwhelming emphasis on academic preparation for science careers for a few students to an emphasis on preparing all students to grapple successfully with science and technology in their own, everyday lives, as well as to participate knowledgeably in the important science and technology-related decisions our country will have to make in the future?" (Harms & Yager, 1981, p. 119) Democracy requires science and mathematics literacy with skills such as critical inquiry. For a given issue, citizens should know how to ask questions, evaluate an argument and supporting data, and identify implications from multiple perspectives (Goodlad et. al., 2004).

As Linda Darling-Hammond (2005) observed, "These are especially critical times for democratic education. The pace of economic, technological, and social change is breathtaking" (p. 1). Science and mathematics teacher education for civic engagement should empower teachers to engage students in science and mathematics learning from personal and societal perspectives and foster skills that provide students with multiple opportunities in an increasingly complex and technologically sophisticated world. Science and mathematics learning should involve students in critical thinking, problem solving, communication, and decision-making from both personal and sociological viewpoints within the applications and contexts of the "real world." Twenty-first century and STEM (for Science, Technology, Engineering and Math) skills are the newest iteration of education in a democracy.

The vision of the science standards is: "All students, regardless of age, sex, cultural, or ethnic background, disabilities, aspirations, or interest and motivation in science...should have the opportunity to... develop the knowledge and skills described in the Standards, even as some students go well beyond these levels" (National Research

Council (NRC), 1996, p. 2). Effectively implementing the standards requires differentiation, with the teacher as a constructivist/inquiry facilitator able to identify and address individual needs. Teachers need to know not only content, but also common student difficulties and ways to effectively address them. They need to know multiple techniques to identify student challenges and to assist students in constructing their own understandings. Understanding subject-specific student difficulties and multiple representations of content, as well as content-specific curricular, instructional, and assessment techniques, results from integrating subject matter knowledge and pedagogical knowledge within practice. This pedagogical content knowledge (Shulman, 1987; Loughran et al., 2006) has been repeatedly identified as crucial in fostering student learning.

WSU strove to improve teacher preparation by enhancing collaboration between the College of Science and Mathematics (CoSM) and the College of Education and Human Services (CEHS) through dual appointments that would bridge the gap between the colleges. Faculty with both content and pedagogical expertise were sought for these positions in order to integrate the content and pedagogical learning of teachers so that they, in turn, could foster meaningful science and mathematics learning for all students.

History and Structure of Dual Appointments

The initial dual appointments were timely because national science and mathematics standards had just been released, Ohio was transitioning to middle (grades 4-9) and early childhood (grades K-3) licensure instead of K-8 certification, and WSU was initiating a professional-year program (5th year) to enhance field experiences, strengthen partnerships, and embed preparation in the contexts of schools. Prior to this time, the few science and mathematics courses required for K-8 elementary education students were primarily offered and taught within CEHS. To enable reform, these courses were moved to CoSM, and dual appointments between the two colleges were created and filled by tenure-track assistant professors with the

primary responsibility of developing and implementing science and mathematics teacher preparation programs.

All of the dual appointees have at least a master's degree in their content area and all have a doctoral degree in either a science or in science or mathematics education. Several of the current science educators have Ph.D.'s in their discipline, and one has doctorates in both the discipline and in science education. The requirement for a minimum of a master's in the content area is necessary due to the positions residing within disciplinary departments. It is imperative that the content expertise of the appointees be respected within the disciplinary departments and that the appointees understand and appreciate the culture of the sciences. The faculty with Ph.D.'s in their discipline did not have degrees in education, but had some level of experience with at least the standards and recommended teaching methods when hired. These faculty faced large challenges in fulfilling their role, since they needed to learn the entire field and culture of education on the job.

In 1995, there were 5 dual appointments (4 science educators and one mathematics educator). By 2005, there were 5 mathematics educators (4 dual appointees) and 7 science educators (6 dual appointees). As of 2011, there are 6 mathematics educators (5 dual appointees) and 12 science educators (8 dual appointees). The growth in the number of appointments was due to two major factors: (a) faculty had significant levels of activity in teacher professional development, research, regional leadership, and external grants, which reduced their time teaching pre-service teacher courses; and (b) the numbers of specialized science and mathematics courses offered increased.

The dual appointments have a majority appointment in either their disciplinary department in CoSM or in the Department of Teacher Education in CEHS. Currently, 11 of the 13 dual appointees have their majority appointment in a disciplinary department. There are 5 dual appointments in the Department of Mathematics, three in Biology, two in Earth and Environmental Sciences, and three in Physics. Chemistry is the only department without a dual

appointment, and currently has one full-time position in chemistry education and one faculty member who transferred from traditional chemistry to chemistry education.

The original appointments were 2/3 in the majority department and 1/3 in the other department. In the quarter system at WSU, this meant that a dual appointee with a 1/3 appointment in the Department of Teacher Education devoted the equivalent of one quarter of effort to this department. The majority department determines the requirements for promotion and tenure, with the other department providing input. Since 1995, other position proportions have been utilized depending on the kinds of activities emphasized by the faculty and the needs of the disciplinary department and the Department of Teacher Education. For instance, because of the number of appointments in science, the most common proportion is 5/6 in the disciplinary department and 1/6 in the Department of Teacher Education. For a dual appointee with a 5/6 appointment in the disciplinary department and 1/6 in the Department of Teacher Education, the typical academic year teaching load is five content courses and one education course, usually a methods course or student teaching supervision seminar.

The appointments have core expectations that have developed since 1995. Dual-appointed faculty are expected to contribute significantly to:

- developing, teaching, and assessing preservice and insevice teacher content and education courses and programs;
- teacher professional development;
- proposal preparation and grants;
- pedagogical research;
- educational outreach and service to P-12 sector; and
- service at department, college, and university levels.

When the university became unionized in 1998, these expectations were translated at a department level into departmental bylaws describing requirements for promotion and tenure.

Administrative Aspects

With the initial dual appointments, there was some inevitable confusion relative to the role of the faculty within both the disciplinary and education departments. Issues of course-load differences between the two colleges, expectations of participation in meetings and various committees (nearly double with two departments and colleges), and expectations of the balance and level of activities with respect to scholarship, teaching, and service occurred. However, the administrators were usually willing to alter assignments or levels as needed to make the appointments work. The willingness of the administrators and the flexibility of the administrators and faculty helped determine how the appointments would evolve. For instance, the initial hires faced a large amount of new course and program development. Thus, their research and teaching overlapped heavily within the scholarship of application. Some confusion occurred in the disciplinary departments about how to assign these activities to the traditional areas of teaching, research, and service in yearly faculty reviews. Currently, there is specific language in departmental bylaws that allows more recent hires to better balance their activities among the three traditional areas. Within the mathematics department, the area of professional practice has helped WSU's mathematics educators categorize their work, although mathematicians still find it difficult to understand and to accept this as legitimate (Reed & Mathews, 2008).

Strong and consistent dean support and communication is imperative. WSU was fortunate that the same CEHS dean administered for the 15 years since 1995 while the appointments evolved. In this same period, CoSM had five deans and a high turnover rate of chairs in each disciplinary department. Therefore, the level of support that the dual appointees had in each disciplinary department varied greatly, depending on the dean and chair. However, the consistency of the dean of CEHS over time and the continual upper administration support helped ensure the support of the faculty in the positions.

Mathematics educators are all part of the mathematics department and have a significant voice at the departmental level, as well as the opportunity for daily communication and collaboration. One of the more difficult aspects of the science education appointments is that they are spread out among four different departments, each with a different chair and with different bylaws. Ongoing communication with the science departments and their chairs has been necessary to continually establish the rationale and attributes of the dual positions.

One of the most frequently cited barriers to reform is the traditional science and mathematics faculty reward system (Advisory Committee to the National Science Foundation, 1996; Caprio, 2001; Hutchings, 2000). In order for these appointments to be successful, CoSM's chairs and dean needed to broaden the college's and departments' views of scholarly work and promote recognition of the particular importance of teaching, educational research, and professional practice in science and mathematics education ─ an essential departure from prevalent policy and beliefs. When WSU was unionized in 1998, each college and each department developed explicit bylaws that state criteria for promotion and tenure. As faculty wrote the bylaws, discussion about expectations and the role of the science and mathematics education faculty occurred regularly. For many dual appointees, this was the first time that their activities and expectations were discussed openly with the faculty of their departments.

The continual communication and leadership of deans and chairs combined with discussions relative to the bylaws led to an increase in department faculty understanding and acceptance of these positions. At WSU, the expectations of each disciplinary department for promotion and tenure of science or mathematics educators is parallel to the expectations of traditional disciplinary faculty. The only major difference is that the science or mathematics educators are expected to publish pedagogical research. Since the inception of the appointments, only one faculty member of those that have applied

for promotion and tenure has not received it, and most of the initial appointees have now been promoted to full professor.

Outcomes of the Dual Appointments

Some examples of collaborative outcomes of the dual appointments are:

- Middle School Mathematics and Science Teacher Program Development;
- Teacher Professional Development;
- The West Center of Excellence in Science and Mathematics Education; and
- STEM Partnerships.

These examples highlight best the synergy between multiple stakeholders and the growth in collaboration and partnerships over time that were initiated by dual appointments and the culture that they helped to create.

Middle School Mathematics and Science Teacher Program Development

Starting in 1997, the initial appointees began designing the "new" early and middle school science and mathematics programs and courses, including the science and mathematics content courses. This was a unique opportunity for science and mathematics educators, who often do not have the opportunity to design or teach content courses for pre service teachers. The dual appointees recognize this as a major factor in their professional growth as science and mathematics educators and in their potential to significantly improve teacher preparation.

Research had identified the critical need for mathematics and science teachers to develop not only a depth of understanding of the content that they teach (Hashweh, 1985, 1987), but also the content-specific pedagogical skills that are necessary for teaching mathematics and science (Ball & Cohen, 1999; Cochran, 1992; Ma, 1999; Shulman, 1987). In WSU's 5th-year licensure model, math-

ematics and science content courses are taken during undergraduate preparation and education courses are predominantly taken during a graduate education program. It was not possible to develop parallel content and education courses to help students learn to teach as they learn the content. Therefore, science and mathematics courses that integrate content with content-specific pedagogy were designed. Within these courses, teaching best practices are modeled and pedagogical content is explicitly addressed.

The initial appointees viewed this endeavor as collaborative program development, rather than individually developed disciplinary courses. All of the faculty shared the philosophy that true reform would only occur when all stakeholders work together in a coordinated fashion toward a common goal. One fear shared by the initial appointees was that if one did not succeed in attaining promotion and tenure, it would be interpreted as a failure of the dual appointment experiment. This possibility caused the initial appointees to support, mentor, and help each other far beyond normal collegiality and helped eliminate unproductive competitiveness.

Crucial to successful, cohesive program development was the shared vision of science and mathematics teacher preparation as described in the standards, coupled with the unique opportunity to create new science and mathematics content courses designated and tailored specifically for education majors. They often worked cross-disciplinarily to achieve common goals (Mathews et al., 2003). At that time, there was little appropriate curriculum available for preservice teachers, so the dual-appointed faculty worked together to develop and pilot the curriculum. External funding (Basista et al., 1998) aided the development of the twelve courses required for the middle childhood science and mathematics concentrations. This funding purchased a mere month of time for course development for each of them, but it allowed the time to form the basis of collaboration with common language, shared goals, and motivation. With their very diverse backgrounds, they needed to share some concrete teaching experiences to "speak a common language." Team-teach-

ing professional development programs provided the shared, concrete experiences that formed the basis for common goals of the programs (Basista & Mathews, 2003).

For 8 years beginning in 1996, they met at least once a month to discuss:

- goals, and obstacles in achieving them;
- course and program development and implementation, including scheduling of courses to fit staffing and students' needs;
- funding opportunities;
- collaborative research, papers, and presentations; and
- design of teacher professional development.

Through regular interactions, they developed their understanding of content-specific pedagogy and how it applied to the teaching and learning of mathematics and science (Anderson & Mitchener, 1994; Cochran, 1992; Lawson, Abraham, & Renner, 1989; Monk, 1994). Based on the current recommendations of the mathematics and science standards documents, and research on teaching and learning (Anderson & Mitchener, 1994; Fitzgerald & Bouck, 1993; Kloosterman & Gainey, 1993; Lampert & Ball, 1998), they arrived at common goals for the programs and courses. These programs provide students with the opportunity to:

- construct their own knowledge through learning cycles of cooperative inquiry;
- gain a depth of understanding of the content and processes of science and mathematics through real-life contexts and applications from personal and social perspectives;
- develop abilities to reason scientifically and mathematically and problem solve;
- understand teaching methodologies that aid the development of these abilities;
- understand the connections between the disciplines;
- gain an appreciation of the history and nature of science and mathematics from social and technological perspectives;

- develop content-specific pedagogical knowledge of how children develop conceptual understanding of specific topics in science and mathematics; and
- develop abilities to communicate through multiple representations.

The developed mathematics program has 9 courses (36 quarter hours), with several courses focused on the process strands in mathematics standards, such as problem solving, representation, and mathematical modeling (see Table 1). The developed science program has 11 courses (45 quarter hours), 3 of them designed as interdisciplinary, integrated science and mathematics courses (see Table 2). All of the courses are specially designed for pre-service teachers and are integrated lecture/lab format with small class sizes of ~ 24 students, which enables cooperative learning, problem- or project-based learning, and many forms of inquiry. The first 3 mathematics courses and the first 5 science courses are taken by both early and middle childhood pre-service teachers. Middle childhood pre-service teachers concentrating in mathematics take the 6 upper-level mathematics courses and those concentrating in science take the 6 upper-level science courses.

Due to the small class sizes and the number of pre-service teachers (about 200 students/year) taking these courses, the overall number of sections each year was staggering. The number of specialized course offerings in mathematics and science for early and middle school teachers needed each year is often near 100. In order to ensure that appropriate faculty taught the courses, the university needed to add more science and mathematics education positions. Today, because of the university's strong commitment to quality teacher preparation, virtually all course sections are taught by doctoral-level, knowledgeable faculty.

Over the years, many assessments of the science and mathematics courses have indicated achievement of program goals. For instance, in PHY 246 where motion and forces are taught, pre/post assessments, including items from known physics conceptual inventories such as the Force Concept Inventory (Hestenes, Wells, &

Swackhamer, 1992) as well as short-answer questions, have indicated significant gains in student understanding of concepts. Since 1997, average pretest scores have been 15-30% and average posttest results range from 70-82%, indicating a significant gain in understanding. Essay questions assessing pedagogical content knowledge of specific topics have also indicated significant increases in understanding, particularly of common student misconceptions. In SM 445, in which students investigate the earth, sun, moon system including seasons and moon phases, students complete both conceptual tests and pre/post interviews. Both the tests and interviews show significant gains. For instance, the 2010 conceptual pretest average was 12% and the posttest average was 86% (N=34), with the interviews providing insights to student understanding and difficulties. In the introductory geology education class, EES 345, 2009 pre/posttest results from the Geoscience Concept Inventory (Libarkin & Anderson, 2005) showed a normalized gain of 0.24, which is in the high range when compared with other introductory geology classes (McConnell & Libarkin, 2009).

In mathematics, assessment has shown that students have grown substantially in their conceptual understanding of big mathematical ideas. For example, in MTH 343, students study functions and their properties, including a beginning study of function continuity. In MTH 348, students investigate continuity more deeply and proceed to limits of functions, one of the most difficult ideas within calculus. Initial understanding is concrete at best; however, current research of students' changes in understanding of limits before and after MTH 348 indicates that students can not only find function limits, but also explain and provide examples. Studies in MTH 446, the capstone course for middle childhood mathematics teachers, show similarly important gains. Many students enter the course not even knowing what mathematical modeling is, much less knowing how to create mathematical models. By the end of the course, they have created models such as one for analysis of effects of ethanol use as a bio-fuel for cars (e.g., determining its effects upon land use in the U.S., the cost of corn in third-world countries, and the effect upon

green-house emissions).

Teacher Professional Development

All the dual appointees collaborated in teacher professional development, including obtaining external funding, and developing courses and programs. School district partnerships have been crucial to the successes of these programs. Developing partnerships with the area districts has required key people from both the university and the school districts to engage in ongoing communications in order to develop and sustain trust, shared vision and goals, knowledge of each others' contexts, commitment, and the desire to change (Shively, 2010). One of the initial dual appointees acted as the primary liaison and most of the faculty visited K-12 classrooms to learn more of what the contexts and needs of the teachers and districts are. The dual appointees frequently met with school district partners to develop the shared vision and goals and to maintain commitments to improve science and mathematics education.

The professional development programs have provided the opportunity to develop and pilot unique curricula for teachers, with the participants providing critical feedback. The curricula are then integrated into the content courses for pre-service teachers, resulting in continual renewal of the pre-service teacher content and education courses. Assessment results of the professional development programs are similar to the pre-service teacher assessment results and indicate significant increases in content and pedagogical content knowledge. Additionally, attitudinal data from a modified Horizon Research Local Systemic Change questionnaire (Horizon Research, 1997) have indicated positive shifts in teacher self-efficacy, preparedness to teach content and utilize various pedagogical techniques, and self-reported use of best practices. Since 2008, an inquiry classroom observation tool, the Reformed Teaching Observation Protocol (RTOP) (Sawada et al., 2002), has been utilized and significant shifts toward inquiry teaching and enhanced classroom culture have been observed.

The initial professional development activity led to designing a "then-unique" program in 1999, the Interdisciplinary Master of

Science in Teaching. The initial dual appointees collaboratively developed the program and courses to meet the needs of K-8 certified teachers seeking to enhance content and subject-specific pedagogical content knowledge for the middle grades or high school teachers with traditionally taught content backgrounds seeking conceptual depth and pedagogical content knowledge. Three-quarters of the program is made up of content courses that integrate content with subject-specific pedagogical content and classroom applications. The program is offered through CoSM and is not housed in any one department due to its interdisciplinary nature. To date, approximately 40 teachers have participated in the program and many of the graduates have gone on to become principals, curriculum specialists, content coaches, or to fulfill other leadership roles.

The West Center of Excellence in Science and Mathematics Education

From 2001-2003 in a unique initiative, the initial dual appointees obtained funding to regionally improve science and mathematics teacher education. Twenty-four faculty of five regional colleges and universities participated in a variety of ongoing professional development activities, such as workshops, courses, and team-teaching, to improve science and mathematics courses and programs for teachers. Throughout the activities, the dual appointees served as mentors and shared their experiences designing, implementing, and assessing pre-service teacher content courses. This professional development formed a strong network through which regional faculty members enhanced their knowledge of inquiry teaching methods, pedagogical content, and teacher education via shared experiences, expertise, resources, successes, and ideas. The network enabled coordinated efforts to improve science and mathematics education and resulted in four major pre-service teacher program developments and 18 content course revisions (Basista et al., 2005). These interinstitutional collaborations and existing P-12 partnerships formed the foundation for a regional center.

The level and scope of activities of the initial dual appointees was noted at the state level, and in 2003, WSU became one of five regional state-sponsored Centers of Excellence, the West Center of Excellence in Science and Mathematics Education (WeEXCEL). This Center is grounded not only in the intra-institutional collaborations of dual-appointed faculty between colleges and departments, but also in its inter-institutional collaborations with other regional colleges and universities, such as the University of Dayton and Sinclair Community College.

WeEXCEL has higher education, school district, educational service center, and STEM Center partners. WeEXCEL focuses on enhancing regional capacity in science and mathematics education through the professional development of P-12 teachers and higher education faculty and through developing and sustaining regional partnerships, with WSU dual appointees in leadership roles. WeEXCEL has supported a significant amount of faculty professional development, with over 40 regional faculty participating in professional development experiences from team-teaching courses, to workshops, to collaborative educational research. Mini-grants have been awarded to collaborative regional groups and from this seed money, six institutions developed or revised middle school teacher preparation programs, including revision or creation of 19 science or mathematics courses and initiation of pedagogical research. Many of the courses developed are modeled after WSU's science and mathematics courses designed by the initial dual appointees. Through this work, WSU gained valuable partners for future initiatives and significantly built regional capacity to initiate and sustain improvements in science and mathematics education.

In the past 6 years, over 1,000 teachers have participated in WeEXCEL externally funded professional development. WeEXCEL's capacity to offer extensive and high quality programs is grounded in the dual appointees' leadership and collaborations with other regional faculty and master teachers, most of whom are prior participants in our programs.

STEM Partnerships

The dual appointees have contributed significantly to two major STEM (for Science, Technology, Engineering and Math) partnerships: the Dayton Regional STEM School and the Dayton Regional STEM Center.

The Dayton Regional STEM School (DRSS) was established in 2008 through a partnership of West Ohio higher education institutions and community organizations, including the Dayton Regional STEM Center. WSU took a leadership role in the development of the proposal for the school, initially funded by the Ohio Board of Regents. The dual appointees helped to envision the school and its curriculum. One of the dual appointees is now the principal of the school, with other dual appointees aiding in curriculum development, research, and interfacing pre-service teacher education with school activities such as science fairs and after-school tutoring.

The Dayton Regional STEM Center (DRSC), founded by a grant from the National Governor's Association in 2007, is another regional partnership of higher education, K-12, government, business, and community organizations with the overarching goal of enhancing STEM education. From 2008-2010, WCSM collaborated with the Dayton Regional STEM Center in the Dayton Regional K-8 Programs of Excellence (DPOE), funded by Ohio's Partnership for Continued Learning. The overarching goals of DPOE were to improve STEM education for all students through teacher professional development and curriculum revision of the partner districts. Twelve partner districts and 120 third through eighth grade teachers participated in substantive professional development that addressed improving STEM education for over 11,000 students. WSU's dual appointees served as lead instructors, assessors, and co-directors for professional development. The program was successful in enhancing teacher content knowledge (measured by pre/post content tests), classroom practices (measured by pre/post RTOP scores), attitudes and dispositions toward teaching, and perceptions of preparedness (measured by pre/post questionnaires).

The DRSC develops STEM curricula for K-12 classrooms. Teams of university, teacher, and local industry fellows collaboratively design real-world project-based curricula that develop 21st-century skills. WSU dual appointees and faculty from other higher education institutions who collaborate with WeEXCEL serve as university STEM fellows, and many teacher STEM fellows are graduates of WSU's programs. WSU dual appointees also serve in other varied STEM initiatives through the DRSC as needed, such as developing "Air Camp" curricula for middle school children and developing a STEM credential for teachers.

Cultural Changes Within CoSM Departments

With so many dual appointments spread among four departments in CoSM and one department in CEHS, one may wonder why science and mathematics education is not departmentalized at WSU. Certainly the logistics, administration, communication, and other aspects involved in the dual appointments would be simpler if they were all within one department. Departmentalization has been considered many times both formally and informally among the dual appointees and the administration, but has always been unanimously rejected. The overriding reason for maintaining the positions within all the different departments is to foster attitudinal and cultural changes among the faculty (and chairs) about science and mathematics education as a profession and as a body of knowledge with application to teaching, and most important, about the critical importance of teacher preparation at all levels. Having dual appointees within these departments greatly increases the interaction of traditional scientists and mathematicians with science and mathematics educators. Faculty and chair awareness and appreciation of issues in teacher education, educational research findings, and methods to improve teaching at all levels have increased. Faculty who want to devote their time and effort toward improving their own teaching practices have expertise and support through the dual appointees and a greater understanding of their endeavors within the faculty. Over the past 15 years, dual appointees have collaborated

with "traditional" faculty to improve courses, programs, and teaching practices beyond the teacher education courses. Likewise, traditional faculty members have contributed to science and mathematics education endeavors by co-teaching teacher content courses, serving as STEM fellows, supporting educational research, and much more. The culture within the departments has changed with interaction that would not have been possible if each of the dual appointees were instead housed within their own disciplinary department.

Concluding Remarks

Dual appointments at WSU have been successful for over 15 years and have not only strengthened teacher preparation programs, but have also contributed to greater awareness and partnership among all the stakeholders. The following are some "lessons learned" about creating environments that support successful dual appointments.

- Dual appointees thrive in collaborative environments. Much of the success of the WSU's initial positions was grounded in the formation of a community with a shared vision and purpose.
- Faculty and administrators must be flexible in their interpretation of the appointments. There are many circumstances that arise in dual appointments that cannot be predicted, so willingness to change in order to make something work or to enable a unique opportunity is needed.
- Stakeholders must share a commitment to making the position "work."
- Clarity is needed from the inception of the appointment with respect to expectations about course load, teaching assignments, research area, service, and outreach, while still maintaining flexibility to alter activities in response to situations or unique opportunities.
- Communication among all administrators and clear support and expectations from provosts, deans, and chairs is imperative. General education of faculty about the purpose and

expectations of the dual appointments is needed to garner departmental support.
- The reward system for promotion and tenure must align with the expectations of the appointment and allow for unique activities that do not neatly fit into the traditional categories.
- A group of dual appointees, perhaps scattered among different departments, should have a voice and allocated resources as necessary. WSU avoided departmentalizing their dual appointments because of the opportunity for cultural and pedagogical changes in all the different departments. On the other hand, departmentalizing would have provided a coherent organization with clear lines of communication to upper administration, and a resource line.

Dual appointees, working cooperatively and with the support of their administrators, have helped to create a local culture of collaboration, not competition. In WSU's region of the state, widespread collaboration and cooperation provide initiatives with access to diverse areas of expertise and the capacity to initiate and sustain improvements through extensive partnerships.

Dual appointments in science and mathematics education at Wright Sate University have been the catalyst to stimulate *human conversations* and to engage in those conversations within and across departments, colleges, the university and our community at large—conversations related to the Agenda for Education in a Democracy and its potential to enrich the mission of our entire institution. As such, we have not only had opportunities to examine issues earlier and more in depth, but moreover, to model nurturing pedagogy for those we teach, provide instruction that reflects the best of our disciplines and to cultivate vital links between our disciplines, the public discourse, and a civil society. In short, we have been able to be stewards of the disciplines that make up the subject matter we teach and to "walk our talk." Postulate Ten (of the twenty postulates developed by Goodlad and his colleagues to define the conditions necessary for quality teacher preparation programs) states that "programs for the education of educators must

be characterized in all respects by the conditions for learning that future teachers are to establish in their own classrooms" (Goodlad et al., 2004, p. 184). Dual appointments at Wright State have served to leverage our network and its infrastructure in ways that have allowed us to ameliorate boundaries that have traditionally resisted change. They have provided a key mechanism for simultaneous renewal across the tripartite—arts & sciences, colleges of education, and public schools. Through our participation in pre- and in-service science and math teacher development, the WeEXCEL Center, and our emergent STEM partnerships, we have ourselves been granted opportunities for:

> critical, disciplined socialization into the full array of expectations and responsibilities a democratic society requires of its teachers. This is unlikely to occur if teaching in schools is seen to require only the generic skills common to all teaching. Nor is it likely to occur if passage through a general undergraduate curriculum and mentoring with an experienced teacher are to be the route to teaching, as is so frequently recommended. Nor is this disciplined socialization commonly occurring in teacher education programs as now conducted. (Goodlad as cited in Goodlad et al., p. 32)

What began as a modest undertaking involving a handful of faculty has steadily grown in scope and complexity as the range of activity has expanded and provided venues through which the uncommon has become ever so much more common. It has been a long, but fruitful endeavor, which continues to strengthen the regional capabilities and capacity to develop educators who nurture learning in and for a democracy.

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Table 1

Middle Childhood Mathematics Education Program

Mathematical Modeling for Middle School Teachers (MTH 446)				
Probability and Statistics for Middle School Teachers (STT 342)	Algebra and Functions for Middle School Teachers (MTH 343)	Geometry for Middle School Teachers (MTH 345)	Problem Solving for Middle School Teachers (MTH 344)	Concepts in Calculus for Middle School Teachers (MTH 348)
Fundamental Mathematical Concepts I (MTH 243)			Fundamental Mathematical Concepts II (MTH 244)	
Quantitative Reasoning (MTH 143)				

Note. All courses are four quarter credits. All early and middle childhood pre-service teachers take the first 12 quarter hours: MTH 143, MTH 243, and MTH 244. Middle childhood mathematics concentration majors take the additional 24 quarter hours as well.

Table 2

Middle Childhood Science Education Program

Projects in Science II (SM 446) 3 credits			
Projects in Science I (SM 445) 3 credits			
Concepts and Applications in Physics II (PHY 346) 4.5 credits	Concepts in Biology II (BIO 346) 4.5 credits	Concepts in Chemistry II (CHM 346) 4.5 credits	Earth Systems (GL 346) 4.5 credits
Concepts and Applications in Physics I (PHY 246) 4.5 credits	Concepts in Biology I (BIO 345) 4.5 credits	Concepts in Chemistry I (CHM 245) 4.5 credits	Concepts in Geology I (GL 345) 4.5 credits
Foundations in Problem Solving and Science Literacy (SM 145) 3 credits			

Note. All early and middle childhood pre-service teachers take the first 21 quarter hours: SM 145, PHY 246, BIO 345, CHM 245, and GL 345. Middle childhood science concentration majors take the additional 24 quarter hours as well.

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