Responding to the Call for Change: The New College of Science Teacher Preparation Program at the University of Arizona

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INTRODUCTION

The reports of several national commissions, like the National Commission on Teaching and America's Future (NCTAF, 1996) and the National Commission on Mathematics and Science Teaching for the 21st Century (NCMST, 2000), have urged higher education institutions to reevaluate traditional practices in teacher education and transform or develop new teacher preparation programs to remedy the major problems identified in these reports. Among these issues are the following:

- Lack of coherence within the teacher preparation programs, fostered by the paucity of communication among subject-matter faculty, education faculty, and experienced teachers in the secondary-school setting;
- Absence of connection and congruence between educational theory that is advocated (e.g., teaching for understanding) and the teaching that is practiced in the subject matter and pedagogy courses and in the majority of secondary science classrooms;
- Deficient subject matter preparation of teachers; and
- Inadequate and unfocused nature of school-based experiences for prospective teachers.

Recent calls for reform of the traditional practices in teacher education have also stressed the need for subject-area colleges to become more accountable for the quality and the quantity of our nation's teaching workforce (Riley, 1998; National Research Council [NRC], 1999, 2000). In this regard, the University of Arizona has a tradition of subject-area colleges taking primary roles in secondary-level teacher preparation. The College of Fine Arts and the College of Agriculture and Life Sciences have well-established programs for undergraduate teacher preparation, run by faculty members with appointments in their respective colleges rather than the College of Education (CoE). In the fall of 1999, the University of Arizona took a decisive step to continue its redistribution of responsibility for secondary-level teacher preparation by developing

a science teacher preparation program housed entirely in the College of Science (CoS). The new CoS Teacher Preparation Program (TPP) was specifically developed and implemented to recruit and prepare undergraduate science majors to become secondary-level science teachers.

The remaining sections of this essay describe 1) the development and evolution of the new CoS-based program, 2) describe the design of the program in response to the reform issues highlighted in the Introduction, and 3) comment on resources and academic issues related to the new program.

THE EVOLUTION OF THE NEW COLLEGE OF SCIENCE-BASED PROGRAM

The shift in responsibility for secondary teacher preparation away from the CoE and toward the subject-area colleges has resulted in widespread university faculty support for models with singular disciplinary foci, built around contextualized education courses that foster the development of pedagogical content knowledge in specific subject areas. The CoS began planning for its new program several years ago when a small group of faculty members and administrators began discussing the elements that needed to be in place to best address the problems described in the national calls for reform of teacher education. These initial efforts were also in response to local concerns about the need for improving relationships between university-level teacher preparation and area schools.

The early discussions about the development of a CoS-based program did not result in immediate support from the CoE faculty and administrators. Gradually, CoE administrators became more supportive as national calls for university-wide distribution of responsibility for teacher preparation became more common. However, the early support from CoE faculty members was mixed. Some CoE faculty members supported the direction of change and welcomed increased participation from their colleagues across campus in the difficult and human resource-intensive process of initial teacher preparation. Other CoE faculty members, particularly those whose teaching careers were primarily vested in initial teacher preparation and who were suspect of what they

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perceived as scientists who knew little about educating teachers, were not supportive and viewed the initiative as a challenge to their professional identity.

However, with the hiring of four new science education faculty members in the CoS, resistance to the new program by the CoE faculty member critics began to wane. The new faculty members, appointed to different departments within the CoS (Astronomy, Chemistry, Molecular and Cellular Biology, and Physics), brought credibility to the CoS initiative. The process of building a program that could be supported by the vast majority of the CoE faculty began in earnest in 1999 with the work of the new CoS faculty members, with expertise not only in science, but also in science teacher education and with secondary-level science teaching experience.

The CoS science education faculty's important work of building capacity for campus-wide responsibility for secondary-level initial teacher preparation continues today. As the CoS program matures, it becomes clear that the work in tandem between the CoS and the CoE has greater potential for successfully preparing a population of highly competent secondary-level science teachers than would be the case if each college isolated itself from the other. For example, the data show that the CoS more successfully recruits undergraduates into science teaching than does the CoE program. Enrollment in the CoS program is growing, while enrollment in the undergraduate science education program in the CoE is declining. On the other hand, postbaccalaureate and second-career students seeking master's-level science teacher preparation programs find better compatibility between their goals and the programs in the CoE. Recruitment territories have thus been established with an agreed-upon goal of increasing the number of well-prepared, secondary-level science teachers. Another example of successful collaboration across colleges is the courtesy appointment of a CoE science education faculty member to the CoS TPP faculty. The CoE faculty member has expertise in educational psychology and teaches a CoS TPP course on student development and student learning in science. These are areas in which the CoS TPP faculty has little expertise. The underlying message in this section, particularly for institutions considering similar initiatives, is that mutually beneficial campus-wide relationships can emerge from conditions that, at first, appear to support only competitive, rather than collaborative, goals. Early dissonance does not necessarily lead to irreconcilable differences.

PROGRAM DESIGN IN RESPONSE TO CALLS FOR CHANGE

As stated earlier, the new CoS TPP was created in response to national calls for change in science teacher preparation (for specific program details see http://scied.mcb.arizona.edu/TPP_home.html). In this section we describe the ways in which the new program addresses each of the reform issues highlighted in the Introduction. In Table 1 we summarize some of the features that distinguish our program from traditional teacher preparation programs. Although the CoS TPP is not unique, it is unusual, especially at a Research I institution.

The CoS TPP was designed and continues to be revised in accordance with research on teacher preparation (Anderson and Mitchener, 1994; Howey, 1996; Richardson, 1996), re-

search on the development of teachers' knowledge and beliefs (Munby *et al.*, 2001; Richardson and Placier, 2001), the recent calls for reform of science education (American Association for the Advancement of Science [AAAS], 1993; NRC, 1996, 1997, 2000), and the evaluation results of collaborative programs in science teacher preparation (National Science Foundation [NSF], 1998; Simmons *et al.*, 1999). The program has also been built with substantial input from faculty in various University of Arizona colleges and an unusually high level of collaboration with local master science teachers (Bell and Buccino, 1997; Byrd and McIntyre, 1999). The remainder of this section identifies the ways in which the CoS TPP is responding to the four reform issues highlighted in the Introduction.

Response to Highlighted Reform Issue 1

The lack of coherence within traditional teacher preparation programs is well documented in the reform literature (see Lanier and Little, 1986; McIntyre *et al.*, 1996). An assumption made by early supporters of the University of Arizona CoS-based program was that developing a small-scale program housed entirely within the college could minimize many of the reported problems associated with the lack of coordination, integration, and coherence among the different program components. This issue was further addressed in the following ways as the program developed: 1) The courses and field experiences in the program are all taught by the new CoS TPP faculty and adjunct instructor master teachers, none of whom carry historical "baggage" into the new teacher preparation program; 2) the four-member faculty and four adjunct instructor master teachers combine to form a well-proportioned blend of knowledge about science, teaching and learning, and secondary-level science teaching; 3) experienced master science teachers (now a group in excess of 30) are engaged in all aspects of program development and implementation; 4) program goals (i.e., core understandings) aligned tightly with national and state standards for science education that guided the development of courses and field experiences were established early on; and 5) a program evaluation model is being developed that, when completely finished, will consist of assessment instruments (questionnaires, concept mapping tasks, video case analyses, portfolios, and target classroom observations) used to measure program effectiveness and individual student progress toward achieving the program's core understandings. We feel that the program, while only in its fifth semester of operation, is well on its way to improving the conditions that led to the concerns associated with the first reform issue highlighted in the Introduction.

Response to Highlighted Reform Issue 2

The disconnected between educational theory and teaching as practiced in schools is also a documented problem in science teacher preparation (Anderson and Mitchener, 1994; Richardson, 1996). This issue is addressed in the CoS TPP in the following ways: 1) involvement of classroom teachers who mentor the CoS TPP students in simultaneous discussions of and professional development on *National Science Education Standards* (NRC, 1996)-based teaching and 2) regular and frequent revision of program courses and field experiences per

Table 1. Comparison of characteristics in the CoS TPP and typical teacher preparation programs

Program characteristic	University of Arizona CoS TPP	Typical 4-year teacher preparation programs
Targeted student population	Undergraduate science or engineering majors	All college students interested in teaching
Required major(s)	Science, Engineering, or Science Education	Education (Secondary)
Program admission requirements	Enrollment in a science major with at least sophomore-level standing	Variable; usually includes GPA, experience with children, junior status
Teacher certification flexibility for undergraduates	Undergraduate majors can simultaneously pursue certification while earning science/engineering degrees	Undergraduates must enroll in the Education degree; postbaccalaureates can enroll in a certification process
Program assessment requirements	Successful performance on separate assessments measuring content knowledge, pedagogical content knowledge, teacher decision-making, and general teaching abilities; measured at four points in the program	Successful performance on assessment of several characteristics observed during student teaching
Number of SMET credit hours	Approximately 90 (in a 120-semester credit science degree)	Approximately 60 (in a 120-semester credit education degree)
Number of graduates	Projection: 10–18/year by 2003/2004	Varies widely; larger secondary science programs graduate 30 teachers/year
Average composite SAT scores of incoming students	1177 (37 scores available for 80 students who have begun the program over 5 semesters)	964 (all U.S. students who took the exam in 2000–2001 intending to major in education) ^a
College in which courses are offered	Science; all courses taught by faculty and adjunct instructors of the CoS TPP; all courses focused on science, rather than general, pedagogy	Education; subject-area methods courses taught in the CoS
Hours of classroom observation prior to student teaching	130	Varies greatly across programs; typically 30–90
Duration of full-time student teaching	Full school district semester (generally two 9-week periods)	10–12 weeks
Frequency of student teacher observations by university supervisors	Weekly	3 or 4 times per semester
Role of in-residence master science teachers	Program decision-making; co-teach all CoS TPP courses; supervise field experiences	Clinical instructors often teach the science methods courses; supervise field experiences
Program philosophy	Theme: Teaching-for-Understanding; unified across program courses and field experiences and grounded by program core understandings	Mixed; at large institutions there is often no one unified philosophy grounding the program
Role of practicing teachers	Input on program decisions; design curriculum for field experiences; cooperating teachers for students' field experiences and student teaching	Cooperating teachers for students' field experiences and student teaching

^aData from the *National Center for Education Statistics* web site.

the advice of practicing master science teachers. We believe that these two efforts provide a cross-fertilization of theory and practice that richly grounds the experiences of the CoS TPP students in a form of theoretically grounded reality. The teachers and the faculty involved in teaching and mentoring in the new program are much closer in our philosophical grounding than would be the case if we had not been communicating and collaborating since the first year of program development.

A major challenge yet to be addressed in the CoS TPP with regard to the issue of the disconnect between theory and practice is how to improve the quality of teaching and oppor-

tunities for learning that exist in science courses for majors (Zeidler, 2002). These courses strongly influence students' beliefs about teaching and learning (Hashweh, 1987). A small effort to influence change is through the modeling of reformed teaching by the CoS TPP faculty members in the science courses that they teach (either introductory majors' courses or general education science courses). But much more can be done. One thing that could be done by the CoS TPP faculty is to take a leadership role in the college in promoting reformed teaching. Another idea that we are considering is developing special courses/seminars that CoS TPP students would take in tandem with key science courses. Our roles as science

teacher educators in such courses would be to help students reflect on the concepts they learn in their science courses, the teaching strategies that foster their own understanding of the concepts, and the ways in which their experiences as students might transfer into productive learning experiences for their future students. Because the program is relatively new, with many issues related to balance of teaching and research for faculty members, our efforts to accomplish these goals are slow.

Response to Highlighted Reform Issue 3

Although we have much more to accomplish with regard to improving the learning experiences of CoS TPP students in our university science courses, we have good reason to believe that the program will prepare competent teachers with strong subject-matter preparation. The following program activities and student characteristics suggest that we are attracting students to the CoS TPP with solid subject-matter knowledge: 1) the recruitment of academically talented science or engineering majors into the program through a state-financed scholarship program (8–10 scholarships awarded per semester); 2) student preference (personal communications with CoS TPP students) for a flexible program like the CoS TPP that allows the completion of a science major, rather than an education major, while simultaneously completing science teaching/learning courses that lead to eligibility for teacher certification; and 3) a relatively high average SAT score of incoming CoS TPP students compared with students indicating education as their intended major on high-school SAT exams (see Table 1).

Response to Highlighted Reform Issue 4

The inadequate and unfocused nature of field experiences and student teaching internships is another well-documented problem in traditional initial teacher preparation programs (see Goodlad *et al.*, 1990; McIntyre, 1983; Watts, 1987; Zeichner, 1987). The inadequate amount of supervision in many traditional teacher preparation programs is exacerbated by the large number of preservice teachers requiring supervision. The unfocused nature of field experiences in many programs is exacerbated by the differences in philosophies and beliefs between education faculty and clinical supervisors, often experienced teachers enrolled in graduate education programs.

The CoS TPP has addressed the issue of inadequate amount of supervision by implementing weekly supervision visits/debriefings with student teachers by master science teacher adjunct instructors who work with the program on a full-time basis. Additionally, the CoS TPP faculty members supervise student teachers, less frequently but nonetheless regularly, as a part of their teaching responsibilities in the program. Also, the program deems the regular supervision of CoS TPP students so important that faculty members and instructors visit classrooms of not only students who are student teachers, but also those who engage in extended observation teaching internships associated with two upper-level courses in the program. This commitment to field experiences in the upper-level CoS TPP courses results in many hours of classroom observation and teaching assistant experience, under close supervision, before the CoS TPP students

even get to student teaching. The small size of the program enables particularly well-focused attention on field experiences. The relatively large amount of classroom time (130 h prior to student teaching), coupled with the shared philosophy that continues to develop between university supervisors and classroom teacher mentors, suggests that the classroom experiences that the CoS TPP receive are also of a high quality.

RESOURCES AND ACADEMIC ISSUES

This essay describing a new CoS-based teacher preparation program in a large research university likely leaves the CBE readership wondering about a few issues related to program resources and within-college support of the program.

Arizona, like many other states, is currently experiencing significant cutbacks in state support for higher education. However, the CoS and university-level administrations regularly acknowledge the importance of the new CoS TPP and state their commitment to its long-term support. The support from the college is substantial. It includes an operational budget and salaries/benefits for four tenure-line faculty positions that did not exist 4 years ago. Grants awarded to the new CoS TPP faculty members from state, federal, and private sources cover the salaries for four master science teachers who work full-time with the program as adjunct instructors, the student scholarships, cooperating teacher stipends, and expenses associated with a new beginning teacher support program. Just as the administration is committed to the long-term support of faculty and operations, the CoS TPP faculty is committed to securing grants for the ongoing operation of the program not currently covered with appropriated funds. We see no immediate alternative to this financial reality. Institutions that are considering the development of similar programs must acknowledge, early on in the process, the amount of resources required to run a field-based, human resource-intensive science teacher preparation program.

Another issue frequently raised by colleagues from other institutions who inquire about the new program is the degree to which the new science education faculty members “fit” into the traditional science departments. Have the CoS TPP faculty members experienced difficulties with tenure and promotion processes? Do departmental colleagues view the work of the science educators with the same high regard afforded fellow researchers in their fields? We believe that our responsibility to the teacher preparation program is widely acknowledged and respected by the CoS faculty and administration. The four new faculty lines were not filled at the expense of research positions. This was an important part of the CoS faculty’s early acceptance of the new science teacher preparation program in the college. Departments had the opportunity to accept or reject potential science education faculty members without losing open-line research positions. After we were hired, more decisions were made that suggest compatibility between the science faculty and the new science education faculty. For example, most of our departments now support science education Ph.D. students advised by us in our respective disciplines. This was not the case in our respective departments before we began our work in the CoS.

However, we have each had to negotiate our individual balance points concerning responsibilities between the

new program and our departments. As tenure-line faculty members, we are all expected to maintain productive research programs in either science or science education, participate in various academic committees, and teach science department courses at the undergraduate or graduate level. Additionally, as experts in science education, some of our colleagues look to us for leadership in revitalizing our department's undergraduate education or developing science outreach programs for the general public. Because such expectations within our departments are often a source of personal concern and interest, we regularly assist in these areas. Consequently, we invest considerable effort to define clearly our academic roles and perceptions within our departments, while educating our colleagues about the nature and demands imposed by our activities in the rapidly growing teacher preparation program.

Questions about criteria for tenure and promotion of CoS TPP faculty members are no more a concern for us than is the case for our science colleagues. Several years ago, the University of Arizona implemented a unique process utilizing a specially appointed committee called SEPTC (Science Education Promotion and Tenure Committee) to review faculty candidates for promotion and tenure decisions. The SEPTC reviews the candidate's file and provides his/her academic unit with a recommendation for promotion and tenure based on carefully developed guidelines for research and scholarly work in science and mathematics education. SEPTC members include faculty members from a variety of academic units across the university. Several CoS faculty members at the University of Arizona have been tenured, promoted, or both, using the SEPTC system. However, science education faculty members have the option of pursuing tenure and promotion through the traditional college process as well, resulting in even more widespread education of our SMET colleagues about the nature of scholarship in science education.

CONCLUDING REMARKS

Universities have recently been challenged to extend their responsibilities for teacher preparation across internal college borders. The University of Arizona CoS has responded to the challenge with the development of a CoS-based program in secondary science teacher preparation. The young program has substantial support from the CoS, the university in general, and local school administrators and master science teachers. The high level of engagement by master science teachers, not only as classroom mentors for the novice teachers, but also as active participants in program development, has created a shared ownership in this unusual program that was created in response to well-documented criticism of traditional teacher preparation programs. It is our hope that readers of this essay will be prompted to consider ways in which their own colleges can more actively participate in the preparation of secondary-level science teachers.

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