The Recruitment of STEM-Talented Students into Teacher Education Programs

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Abstract: *This paper begins by identifying three main reasons why many of the more STEM-Talented students at our universities do not consider enrolling in STEM teacher education programs. Then based on a review of the literature, a framework for addressing this dilemma is presented and discussed. This framework consists of a set of three principles together with eleven strategies for the operationalization of these principles. During the presentation of the framework, the roles of governments and of universities at the institutional, faculty/division and departmental levels in the operationalization of the framework are examined.*
Keywords: teacher education, recruitment, pre-service teachers, STEM-literate

1. Introduction

In order for the vision of "new" STEM programs to be realised, teachers need to have not only well developed repertoires of content knowledge about the STEM disciplines but also knowledge about the nature and discourse of the STEM disciplines, knowledge about STEM disciplines in culture and society, and positive dispositions towards the STEM disciplines (Lederman, Gess-Newsome, & Latz, 2006; Vokos et al., 2010). Unfortunately, most current pre- and in-service teachers do not possess such repertoires of STEM knowledge (Ball, Lubienski, & Mewborn, 2001; Parker & Finkel, 2011; Petish & Davis, 2001). It has been suggested this issue can in part be addressed by the recruitment and retention of more STEM-Literate students into teacher education programs. Unfortunately, many STEM-Talented students at universities in most countries currently tend not to consider teaching as a viable career path (Lawrence & Palmer, 2003; McInnes, Hartley, & Anderson, 2001; Thorne, 2010). In this paper, after a brief review of the literature, we present a framework to address this dilemma and identify and discuss factors that could impact on the operationalization of the framework.

2. Why STEM-Talented Students Do Not Enrol in Teacher Education Programs

A review of the literature indicates three major reasons for why many of the most STEM-Talented students enrolled in our universities tend not to consider teaching as a career path:

1. Limited interest in teaching careers;
2. Existing cultures within STEM discipline faculties; and
3. Too narrow recruitment nets.

Each of these three issues will now be discussed in turn.

2.1. Limited Interest in Teaching Careers

Many university students studying STEM disciplines tend to have limited (and in many cases incorrect) information about the possibilities offered by a career as a teacher of STEM. Therefore, one strategy that has been successfully applied to address the issue of limited interest in teaching careers is to provide students studying STEM discipline subjects with a survey that first asks them to think broadly about the factors relevant to choosing a career and about the kinds of careers they would like in their working life, second to examine teaching careers, and then third inform them about teacher education programs available at their university (Thorne, 2010).

Another strategy that has been utilized to stimulate students' interest in STEM teaching operates on the students' financial nerve – the awarding of STEM teaching scholarships. One such example is the Robert Noyce Teacher Scholarship Program (National Science Foundation, 2011) in the United States. This Program seeks to encourage talented science, technology, engineering, and mathematics majors to become K-12 mathematics and science teachers. The Noyce Scholarship Track provides funds to institutions of higher education to support scholarships, stipends, and academic programs for undergraduate STEM majors and post-baccalaureate students holding STEM degrees who earn a teaching credential and commit to teaching in high-need K-12 school districts.

A third strategy that has been successfully applied to address this issue has been the appointment of undergraduate Learning Assistants (Otero, Pollok, & Finkelstein, 2010; Smith, 2010; Thorne, 2010). This strategy, exemplified by the PhysTEC program (Finkelstein et al., 2006; Otero et al., 2010) at the University of Colorado, has been adopted in nine science, mathematics, and engineering departments at the University of Colorado and also at many other universities (Smith, 2010; Thorne, 2010). In the programs based on the Colorado Learning Assistant Model[1], talented undergraduate STEM majors have been hired as LAs to assist interested faculty in redesigning their large-enrolment introductory STEM courses so that students have more opportunities to articulate and defend their ideas and interact with one another. According to Otero et al. (2010), LA programs have four main goals:

1. To improve the education of all science and mathematics students through transformed undergraduate education and improved K-12 teacher education;
2. To recruit more future science and math teachers;
3. To engage science faculty more in the preparation of future teachers and discipline-based educational research; and
4. To transform science departmental cultures to value research-based teaching as a legitimate activity for professors and their students.

Initial evaluations of the LA programs at Cornell and Colorado indicate benefits both in generating interest in teaching careers and in their undergraduate physics program as a whole. For example, Otero et al. (2010) report that since the inception of their LA program at the University of Colorado in 2003, they have increased the pool of well-qualified K–12 physics teachers by a factor of approximately three, engaged scientists significantly in the recruitment and preparation of future teachers, and improved the introductory physics sequence so that students' learning gains are typically double the traditional average. Finkelstein (2010) reports that as a result of the LA program, the University of Colorado has more than doubled the number of physics and chemistry majors getting certified to teach in these hard-to-staff subject areas. He reports that the program also has positively impacted graduate students (who are departmentally assigned Teaching Assistants) and future graduate students – the bulk of LAs have gone on to graduate school and carried their mastery of content and pedagogy with them.

2.2. Existing Cultures within STEM-Discipline Faculties

Unfortunately, the culture pervading in many STEM discipline faculties is at best one of apathy when it comes to the recruitment and education of STEM teachers (Otero et al., 2010). Strategies proposed to change this culture include teacher education faculties: 1) making regular presentations about their STEM education courses to STEM faculty and graduate students; 2) reminding them why training more STEM teachers is critical to their department, university, profession, and country; 3) inviting them to help in promoting teaching careers and in identifying and recruiting students with teaching interests; and 4) pointing them to useful advisory resources (Finkelstein et al., 2006; Thorne, 2010).

[1] Colorado Learning Assistant Program, see: http://stem.colorado.edu

2.3. Too Narrow Recruitment Nets

A review of the literature reveals that throughout the world, teacher education programs have tended to cast rather narrow nets when engaged in the process of recruiting students into pre-service STEM teacher education programs. A broader net can be cast in many ways. One strategy is to focus on STEM discipline students who do not intend to major in these disciplines. Data from many OECD country research universities indicates that a large proportion of students enrolled in science and mathematics courses do not intend to have careers in these disciplines (Thorne, 2010; Watt, Richardson, & Pietsch, 2007). Thorne (2010) argues that many of these students could have excellent careers as teachers and thus should be given information about teaching as a career. In PhysTEC program at Cornell University, they do this by examining more than a dozen career choice factors and how school physics careers stack up. According to Thorne, by most metrics, the answer is: very well.

A second strategy for casting a wider net is to overtly focus on STEM discipline graduate students failing to complete their programs. Data from OECD country universities indicates that a considerable proportion of students who enter PhD programs in the physical sciences and engineering do not progress to completion. Presently, few of these students consider and/or proceed onto STEM teaching careers. However, this can be addressed by having recruiting efforts specifically targeting these students (Thorne, 2010).

A third strategy for casting a wider net is to recruit career changers with real-world experience in the fields of mathematics, science and engineering (Foster, 2010; Levin & Quinn, 2003; National Science Foundation, 2011; SEARCH EnCorps, 2008). This strategy has the added benefit of providing teachers with real world experience in the fields of mathematics, engineering and science who have the potential to "ignite student interest by sharing how math and science can be used to create and build new worlds rather than viewing them as dry academic subjects" (SEARCH EnCorps, 2008, p. 4). Hardy, Howes, Spendlove and Wake (2008) also found that pre-service teachers with prior industrial and other relevant experiences are more enthusiastic about the process of boundary crossing between disciplines than those who come directly from school or university education.

A fourth strategy for casting a wider net has been a strategy discussed earlier in this paper: implement undergraduate Learning Assistant (LA) Programs. This strategy has been found to be most effective when combined with a fifth strategy: *STEM Teachers in Residence Programs*. At both Cornell and Colorado universities, they have found that the Physics Teacher in Residence has played a crucial role in mentoring LAs, in sustaining their enthusiasm for teaching, as an authority on high school physics teaching careers, and as a role model (Otero et al., 2010; Thorne, 2010).

3. Framework for the Recruitment of STEM-Literate Candidates

From this review of the literature, we have generated a framework consisting of three principles and a set of eleven strategies for operationalizing the principles (see Figure 1). Principle 1 focuses on changing attitudes and stimulating STEM-discipline students' interest in teaching. Principle 2 focuses on changing existing cultural barriers to STEM teaching careers within STEM-discipline faculties/divisions in many universities. Principle 3 focuses on broadening the recruitment net.

The enactment of Principle 1 can be facilitated by the application of Strategies A, B, J and K. Strategy A's major purpose is to provide STEM-discipline major students with information about teaching and stimulating their interest in STEM teaching careers. This strategy can be enacted by teacher education faculties, STEM discipline faculties, or preferably by *both* teacher education and STEM discipline faculties. Strategy B focuses on the provision of financial awards to stimulate students' interest in STEM teaching careers. The financial resources to underwrite these scholarships can come from four sources: government, universities at the institutional level, universities at the faculty/division level, and universities at the departmental level. If the financial resources originate from government and/or universities at the institutional level, then this strategy can act as a catalyst for cross-division collaboration between the teacher education and STEM discipline faculties/divisions and departments for not only stimulating STEM discipline major students' interest in STEM teaching careers but also in stimulating reforms in undergraduate STEM discipline courses. This is particularly so if Strategy B is implemented in consort with Strategies J and K: Undergraduate Learning Assistant Programs and STEM Teachers-in-residence Programs. The funding necessary for underwriting the implementation of Strategies J and K can come from governments, universities at the institutional level, universities at the faculty/division level, and at the university department level. However, the most effective implementation of Strategies J and K has tended to occur when the operationalization of these two strategies was instigated, planned and implemented as a collaborative endeavour by the teacher education and STEM discipline faculties/divisions and departments within universities. The participation of the education faculties/divisions and departments ensured that the pedagogical soundness of the programs was established and maintained whilst the participation of the STEM discipline faculties/divisions and departments ensured that the intellectual and cultural integrity of the disciplines was established and maintained.

The enactment of Principle 2 can be facilitated by the application of Strategies C, D, E, and F. The major impetus for the application of these strategies should come from the teacher education faculties/divisions and departments. However, the effectiveness of the application of these strategies can be enhanced by the active participation of academics and administrators from the STEM discipline faculties/divisions. This is particularly so if the STEM discipline academics and administrators are passionate about proselytizing to students of all ages the benefits of studying and becoming part of the community of practice of their particular STEM disciplines.

The enactment of Principle 3, casting a broader recruiting net, can be facilitated by the application of Strategies G, H, I, J and K. The effectiveness of the application of Strategies G and H is highly dependent on the levels of cooperation and collaboration between the teacher education and STEM discipline faculty/divisions and departments in the universities. Members of the STEM discipline faculties/divisions and departments play crucial roles in the identification of these potential STEM teacher education students. Both the teacher education and STEM discipline faculties/divisions together with the university at the institutional level play crucial roles in providing the course structures (and regulations) that enable smooth transition of the students from STEM discipline programs into STEM teacher education programs.

The successful application of Strategy I, the inclusion of “STEM professional career changers”, is highly dependent on course policies and regulations operating at the institutional level. When we examined the course enrolment regulations of many universities in Australia and the US, we (like SEARCH EnCorps, 2008) found that rather than facilitating the enrolment of STEM career professionals interested in a career change into STEM teacher education programs, many of the regulations almost certainly would have the opposite effect. Unless more flexibility is built into the enrolment and course regulations of universities at the institutional level, it is highly unlikely that this potential source of future STEM-capable candidates will be adequately exploited (SEARCH EnCorps, 2008). Decisions made at the faculty/division and departmental levels impact largely on how and what ‘career change” teacher education students study during the course of their pre-service programs. For example, in many of the STEM teacher education programs from universities in Australia and the US that we examined, STEM professional career changers were required to study courses almost identical to those studied by recent high school graduates. The inflexibility of these course structures and procedures not only failed to take cognizance of and utilize the STEM professionals’ rich repertoires of experiences, expertise and knowledge but also tended to provide time and financial disincentives for the STEM professionals to enroll in the STEM teacher education programs.

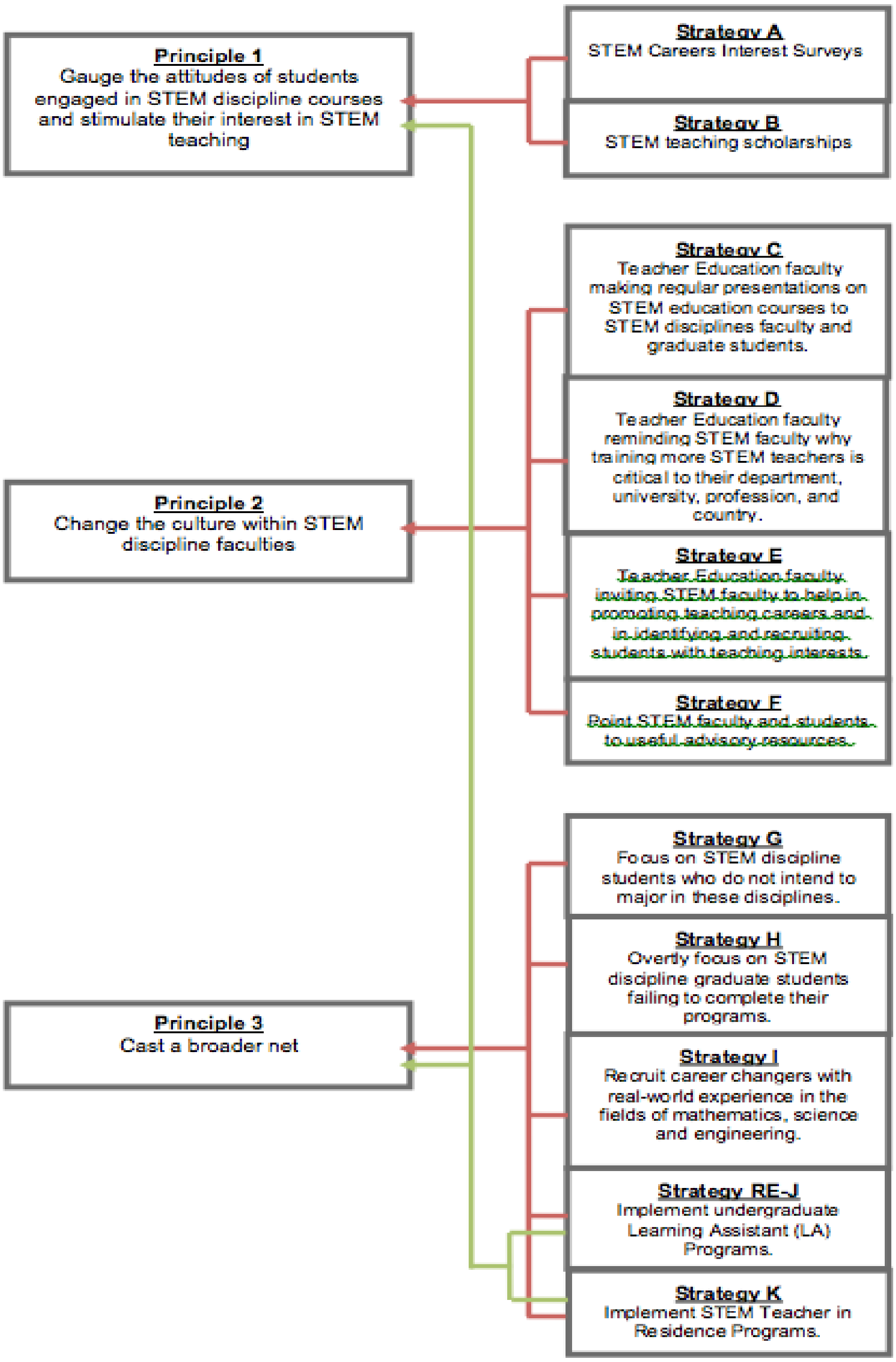

Figure 1. Framework for recruitment of more STEM-capable students into STEM teacher education programs.

4. Conclusion

In this paper, we have presented a framework to address three sets of issues that the literature indicates are the major reasons why many of the more STEM-literate students in our universities do not enroll in STEM teacher education programs. This framework consists of three guiding principles and eleven strategies for the enactment of the principles. The enactment of the framework requires significant investment of financial and personnel resources from not only governments, but also by universities at the institutional level, by universities at the faculty/division level, and by universities at the departmental level.

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