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Existing specialty schools as leverage for behavioral sciences research on teaching and learning in STEM fields

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Abstract

The National Science Foundation has requested comments and proposals that outline challenge questions for the next decade in behavioral sciences research. At the same time, the NSF has joined the President's Council of Advisors on Science and Technology as well as the National Academy of Sciences in issuing reports identifying the need for specialized STEM education as a strategic necessity and proposing the establishment of an additional 1000 specialized STEM schools. A common theme in these reports is that foundational work must be conducted to establish effective organizational and instructional practices for these schools. The authors of this paper serve as directors of a national organization of 92 such schools; as representatives of two of the schools used as exemplars in the PCAST report they challenge the National Science Foundation to engage and extend existing research relationships with these willing laboratory schools as a means to accelerate work in the learning and behavioral sciences that must be conducted for this national endeavor.

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Challenge Background

This paper is a response to the Dear Colleague letter regarding SBE:2020 Future Research in the Social, Behavioral & Economic Sciences. As the National Science Foundation works to identify the challenges that will be addressed by the next generation of researchers, they do so at a time when the academic ecosystem upon which we rely is in danger. The creation of grand challenge questions for the next generation of SBE research also implies that a generation of researchers will be developed who are capable of engaging such questions. The call for papers is timely given the confluence of the release of 3 national reports on the state of STEM education and recommendations for improvement, this is a challenge particularly to the Cognition and Learning division, which should look for opportunities to research "pipeline" issues related to initiation and persistence of learners.

The National Academy of Sciences (NAS) recently released an update to its 2005 report on the state of STEM education. This update, *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5*, outlines five years of efforts to address America's strategic competitiveness in science and innovation. The NAS identified in their initial report that "the most pervasive concern was considered to be the state of United States K-12 education, which on average is a laggard among industrial economies." The authors, looking at five years of subsequent policy and legislative effort, conclude that this situation has "worsened" and "has shown little signs of improvement, particularly in mathematics and science." With respect to the establishment of STEM specialty schools they note that while Congress authorized $89 million

for this effort, no monies were appropriated or specified in the past five years. The National Academy of Sciences again recommends that strengthening public education is a necessary step to avoid a catastrophe in innovation and international competitiveness.

At the end of this five year period and near the same time as *Gathering Storm Revisited*, the President's Council of Advisors on Science and Technology (PCAST) issued a report to the President, *Prepare and Inspire: K-12 education in science, technology ,engineering, and math (STEM) for America's future*. The challenge that this group identifies is that "STEM education will determine whether the United States will remain a leader among nationals and whether we will be able to solve immense challenges in such area as energy, health, environmental protection, and national security." The PCAST report, like the original *Gathering Storm*, suggests that the means of achieving these strategic goals includes the identification of talent in STEM fields and the development of talent through specialized STEM schools. In fact, the PCAST report goes so far as recommending the creation of 1000 such schools over the next decade and that "the Department of Education and the National Science Foundation should develop a joint plan for accomplishing this goal, through funding and technical support."

The National Science Board at the NSF also issued a report on this urgent issue in the summer of 2010, *Preparing the Next Generation of STEM Innovators: Identifying and Developing Our Nation's Human Capital*. The key idea is on talent identification, and as with the other reports the development of differentiated or accelerated instruction is recommended. The goal in the NSF report is to build the ecosystem; however, it goes further than others in understanding the need for research on how such talent can be identified and appropriately cultivated from identification to professional practice over a period of time that may take a decade or longer.

Why challenge the NSF/SBE?

The challenges outlined above seem to refer strictly to STEM domains, we find that it is important to remember that STEM only delimits the content, methods, and ways of thinking. **The primary challenges surrounding the identification and development of talent are firmly rooted in the division of Cognition and Learning within the SBE Sciences Directorate.** We also feel that the same issues related to talent identification and development in STEM fields affect the creation of scientific minds in the SBE sciences. Attacking the identified problems of STEM education, or treating STEM education as a cause, when it is really an effect. The current state of education (or of scientific and economic competitiveness) is the result of a gaps created when talent development, or specific academic abilities, has been ignored in favor of a generalized curriculum that focuses on content standards and less on the critical thinking skills which are required for interdisciplinary thought, analysis and idea creation. It is possible to look at schools that have created successful STEM programs and find, in many cases, that there is in place excellent models of talent development and academic alignment. The STEM talent crisis is not so much caused by the organization of our system of education, but rather the inefficient system is itself an effect of decades of neglecting talent development as the primary oucome.

The authors of this paper serve on the board of directors of a national consortium of specialized schools that focus on STEM, and they both represent institutions used in the PCAST report as exemplars of models for the next generation of specialty schools. In addressing this challenge to the SBE sciences directorate we recognize two things. First, we recognize that the learning and behavioral sciences are key to the identification and development of talent, and that there has been a paucity of attention paid to high achieving children and adolescents. Second, we

recognize a direct relationship between our institutions and the next generation of researchers in the SBE sciences; the development of scientific habits of mind often leads exceptionally talented students who started on a strictly STEM pathway into those fields.

We identify this challenge for the SBE science directorate because we feel that the development of the talent necessary to meet its grand challenges will rely on institutions such as ours. We also realize that the research agenda in the behavioral sciences will need to include field research in talent identification and development. While the primary research burden will be on the behavioral and learning sciences, the development of domain-specific expertise will involve contributions from experts in all STEM and SBE science disciplines.

$t \neq 0$

In research in which observations are made over time, t=0 represents a starting point, a fixed referent designating where things begin. The NSF, PCAST, and NAS have identified the development of additional capacity in specialized education as a priority, and we hope that there will be an increase in both interest and investment surrounding research on such institutions. Time need not be wasted - time, which is important in the STEM competition for national success, can be best and most efficiently used by looking at the diversity of successful programs which already exist. We restate that $t \neq 0$ to stress that there exist 92 specialized schools in 18 states that have histories that are, in some cases, over 90 years old.

The schools are as diverse in design as the communities in which they exist: stand-alone schools, residential schools, co-located or regional magnet programs, and a growing number of schools located on college campuses. Some of these schools include applied technology as part of meeting their community's needs, while others have students engaged in academic inquiry that leads to publication before they have even earned their diploma.

While these specialized schools have been around for many decades and have secured many accomplishments, they have rarely acted as laboratories themselves. In the past few years, however, there have been some changes that make them more attractive as collaborators. Engagement with policy makers led to the language in the America COMPETES Act that allows specialized schools to work directly with the NSF in major data collection under funded research (Sec. 513). Additionally, the NSF has funded, through the American Psychological Association, a *Study of the Impact of Specialized Public High Schools of Science, Mathematics, and Technology*, that will look at educational and career outcomes of several thousand alumni from 20 specialized high schools. In 2010 $t \neq 0$ because the outcomes of the models can be studied and understood through decades of graduates.

Conclusion

Despite the promise of recent collaboration and research, we challenge the National Science Foundation to increase its engagement in programs that develop the next generation of scientists and social scientists. As we look at strategic issues related to competitiveness and innovation, we might be concerned that last year 13 of the 21 delegations visiting the Illinois Mathematics and Science Academy from out-of-state actually represented foreign interests. These schools hope that the development of a national agenda will include an increase in utilizing them as laboratories to help meet America's strategic goals.

The NSF/SBE has invited individuals and groups to outline challenge questions for the coming decade. We believe that the identification and development of talent in both STEM and SBE science domains represent not only a new cycle of research, but could also serve as a transformative impulse leading to changes in education practices related to these issues of strategic importance. The effects of these specialized schools will need to be measured for the

purposes of advancing the behavioral and cognitive sciences, and will ultimately lead to issues that need to be addressed by the social and economic sciences division as public education and the constitution of the workforce change. As the NSF/SBE identifies the grand challenges for 2020, their planning should see the experiences of these willing partners in inquiry as leverage in designing and building institutions that will create the next generation of scientific minds. The existence of this network of established institutions creates immediate capacity for scholars and graduate students to engage in active research on teaching and learning that will have immediate applicability throughout the existing K-12 infrastructure.

References

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