Understanding the STEM Teacher Pipeline:
Early Findings from a Review of Selected NSF Noyce Program Evaluations

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Abstract

Early findings from a review of National Science Foundation Robert Noyce Scholarship program evaluations in Science, Technology, Engineering and Mathematics (STEM) teacher preparation for high need school districts showed mixed results. The Robert Noyce program is intended to increase the preparation and supply of STEM teachers to high need schools. The evaluations reviewed (N=11) were collected through an internet search and they represented approximately 989 participants (including students, faculty members, alumni, and mentors). Two of the evaluations did not share the numbers involved. The review of the Noyce evaluation reports focused on the purpose, procedure, participants, methods, results, and evaluative recommendations to the program. The evaluations have employed a variety of data collection strategies to include both quantitative and qualitative methods. Findings include the importance of opportunities for reflection, mentoring, time spent in high need settings, and professional development. Not every scholar fulfilled their scholarship commitment. Implications for STEM recruitment, teacher preparation, curriculum, mentoring, employing school districts and policy are discussed with recommendations for Noyce programs.

Introduction

The need to prepare, place and retain high-quality teachers in science, technology, engineering, and mathematics (STEM) subjects throughout the nation's public schools, particularly in high need districts is well established (President's Council of Advisors on Science and Technology 2010). However, ensuring equal access to quality teachers in high need schools remains a challenge. The Robert Noyce Teacher Scholarship Program at the National Science Foundation (n.d.) provides funding to support the recruitment and preparation of teachers in STEM areas for high need schools. Identifying factors that lead to successful recruitment and retention, with a particular at

tention to graduates of the Robert Noyce Teacher Scholarship Program (hereafter the "Noyce program") might shed light on the effectiveness of the program with insight to policy. In this context, evaluations of Noyce programs are of great interest as they provide insight for successful policy and practice.

Purpose

The purpose of the study is to review evaluation reports from Noyce programs to gain understanding of the preparation of STEM teachers for high need schools. According to the National Science Board (2010), the strength of the nation's workforce and economy, and global competitiveness rely heavily on STEM fields. Yet, the U.S., once a leader in STEM student achievement among developed countries, has experienced a relative decline over several decades (President's Council of Advisors on Science and Technology, 2010; National Research Council, 2010). Consequently, increasing the competency of K-12 students in STEM subjects has become a priority for U.S. policymakers.

Establishing a steady pipeline for the supply of high-quality STEM teachers into K-12 classrooms across the country is a key strategy for improving student achievement in STEM subjects (President's Council of Advisors on Science and Technology 2010; National Science Foundation, 2013). Teachers remain one of the most influential factors positively impacting student learning (Kumar and Scuderi, 2000). However, for various reasons, the STEM teacher pipeline is not sufficient to supply the steady flow of teachers to offset hard-to-fill vacancies, low levels of teacher qualifications, and excessive turnover, especially in high need school districts (Feng, Hansen, and Kumar, 2021). For example, teacher turnover remains one of the major challenges haunting high need school districts. In high-poverty schools, 20% or more of their teaching faculty leave each year, and over half of teaching staff are replaced every five years, and these rates are considerably higher than low-poverty schools (Simon and Johnson, 2013). Irrespective of the fiscal and logistical challenges caused by excessive teacher turnover, it appears to have a damaging effect on student achievement, across demographic boundaries (Ronfeldt et al., 2013).

Background

The Robert Noyce Scholarship Program is one of several efforts by the National Science Foundation (n.d.) to address the critical need for supplying and retaining highly qualified elementary and secondary STEM teachers in high need school districts. To achieve this goal, the Noyce program provides Scholarships for talented STEM undergraduate/graduate majors and professionals to become effective K-12 STEM teachers. Institutions receiving Noyce funds develop partnerships across departments to involve faculty from both sciences and education to develop strong content knowledge among Noyce scholars, then offer mentoring and induction support in the field (Feng,

Hansen, and Kumar, 2021). The Noyce program provides support in three tracks; Track 1 – Scholarships and Stipends, Track 2 –Teaching Fellowships, Track 3 – Master Teaching Fellowships; and evaluation support; Track 4 – Research. Relatively little is known about how the teacher candidate pools in Noyce programs develop and evolve as scholars progress through the Noyce programs.

Noyce Scholars are students in a Noyce STEM Teacher Preparation program who receive Noyce Scholarship funding, on the condition that they work for a minimum of two years in a high need school district upon graduation. According to the National Science Foundation (2013) a high need school district has at least one school with over 50% of the students enrolled eligible for participation in the Free and reduced - Price Lunch program, and has at least one school, in the last three school years, with teacher attrition rate at 15% or higher.

After over fifteen years in existence, spending millions of taxpayer dollars in grants, there is relatively little empirical evidence available on the effects of the Noyce program on the supply of STEM teachers in high need school districts. Therefore, it is very important that we learn more about the preparation and supply of STEM teacher workforce in high need school districts, and how to ensure equal access to high quality teachers.

In 2020, Florida Atlantic University (FAU) received an NSF Noyce Track 4 Research grant. The FAU research grant is part of a Noyce partnership with the Brookings Institution and Texas State University, and four collaborators; the University of West Florida, Florida International University, Texas State University and University of Texas Arlington. FAU is leading one of the three major objectives of this project using a mixed method study. Some of the major research questions of this multi-stage and multi-year project are: What are the demographics and qualifications of the STEM teacher candidate pool, and how do they change during the preparation process? Do different programs have varying levels of success getting high-priority candidates through their programs? How do local high need districts perceive teachers coming from Noyce institutions, and has the availability of the Noyce program graduates reduced staffing challenges? The mixed method study takes place in three stages; Programmatic data inventory (Kumar, Moffitt, and Verner, 2022), Alumni survey, and Interviews with university program and school district staff. To gather background information for this multi-pronged research of Noyce programs, a review of selected Noyce program evaluations was undertaken.

Method

The review of the Noyce program evaluation proceeded as follows. An internet search using the terms Noyce, Evaluation, STEM, Track 1, Track 2, Track 3, Track 4 in various combinations re

sulted in 38 documents. A review of the 38 documents, after eliminating duplications (e.g., multiple publications and presentations of the same study) resulted in 11 usable evaluation reports for the review, representing approximately 989 participants (including students, faculty members, alumni, and mentors). Two of the evaluations did not share the numbers involved. The evaluation reports reviewed are as follows: Alemdar et al. (2018), Greer (2015), Lawrenz et al. (2008), Manning et al. (2012), McCoy (2020), Mumford and Newcomer (2019), Sampson (2012), Travis et al. (2014), Wang (2014, 2013), and Whitefield (2017). The review of the Noyce evaluation reports focused on the following factors; purpose, recruitment, procedure, participants, methods, results, and evaluative recommendations to the program.

Early Findings

The main theme across the evaluations in terms of their purpose is to find qualified educators who can teach in a high need school district with a STEM concentration and program ability in improving teacher quality. A majority of Noyce programs evaluated are from public institutions.

In terms of procedure, the data was collected via surveys, phone call interviews, observations, and other resources. Also, recruitment processes occurred through marketing strategies such as institution websites, STEM programs, flyers/brochures, social media, or school events. It should be noted that one evaluation used a Perceived Stress Scale due to the fact that the evaluation was conducted when COVID-19 first emerged.

The total number of participants (including students, faculty members, alumni, and mentors) was approximately 989. Two of the evaluations did not share the numbers involved. Out of the 11 evaluations reviewed, 2 reports consisted of post graduates of the program, 2 reports consisted of faculty members or mentors to help participants in the program to achieve their needs in terms of teaching at a high need school and 2 included non-Noyce Program participants.

Not every evaluation analyzed reported clear and consistent demographic data. Four evaluations provided information on the gender demographic of participants. Four reported the ethnicity of their participants, but only two provided both white and minority groups.

An overarching theme, efficacy, was evident in the evaluations. Efficacy helped to empower scholars to develop expertise by trying out new ideas, and building confidence to teach in high need schools. It also enabled scholars to develop and teach meaningful STEM lessons. As a result, the Noyce scholars were prepared to teach at a high need school at the end of their program.

Another theme found was that an individual's motivation to apply to the program might be due to the incentive the Noyce scholarship provided. A few scholars used the scholarship to develop their research experience and skills. There is no evidence that these scholars intended to teach.

The importance of mentoring was found in 6 of the evaluations. Mentors in one program were dedicated master teachers who joined the program for one year. Mentoring was seen as an important variable to create positive perceptions. Not every scholar fulfilled the scholarship commitment. Some scholars reported poor treatment of teachers by school administration, low salaries, and difficulty finding jobs in high need schools.

Evaluative Recommendations

In addition to presenting their findings, most evaluations reviewed also made recommendations for improvement. Some of the common themes emerging from their recommendations: 1) develop a targeted selection process for identifying STEM students interested in teaching 2) prepare for the realities of teaching in high need schools, 3) provide tailored opportunities (e.g. shadowing an experienced STEM teacher) for teaching in high need classrooms, 4) provide summer opportunities to work in "unfamiliar" school districts under the supervision of experienced STEM teachers to broaden scholars' understanding of the actual value of teaching, 5) engage in "courageous" conversations about race and ethnicity with Noyce scholars, 6) provide more assistance with job placement, and 7) enhance opportunities for team building and community development before and after graduation from the Noyce program.

Discussion, Implications and Recommendations

Considering the limited sample size, it is difficult to generalize the findings of this review of Noyce program evaluation reports. Efforts should be made to increase the sample size with additional relevant Noyce program evaluation reports. It should be noted that an accurate number of participants was not clear as reported by some evaluation reports reviewed, leading to approximations based on available information. Based on the reports reviewed, the Noyce programs are preparing STEM teachers for high need schools. A majority of the Noyce programs evaluated are in public institutions. Most of the evaluations also indicate the need for improvement. One evaluation conducted a Stress Perceived Scale along with interviews due to the fact the evaluation was conducted when COVID-19 first emerged. It is clear from the reports that the relationship of the school district and the university is paramount to the success of the program. Assistance with placement of scholars in a school involves the support of school district partners. Mentoring is a prominent mention throughout the reports. A strong mentor can guide and assist the scholar to develop a stronger sense of reflection and efficacy to become a more confident teacher in a high need school. In one report the entire advisory board acted as mentors (Wang, 2014). This program resulted in 87% of the graduates willing to remain in high need schools after graduation.

Findings from the reports reviewed indicate the need for policy to support STEM teaching at all levels. Scholars felt a lack of support for their work in high need schools. The STEM industry provides many opportunities for individuals in society. Teaching is not the highest paid of these opportunities. In order to keep STEM field experts in teaching, policy should be developed to recruit and keep qualified STEM teachers in high need schools. This policy work must include guidelines and expectations for STEM degree teachers.

It is clear that the Scholars are better able to manage the program and the teaching responsibilities with the support of a mentor. The authors recommend that the Noyce program grant include mentor support through a structured mentor program to all scholars who are a part of the Noyce Scholarship STEM program. Efforts must continue to maintain demographic records of Noyce scholars throughout the program. This will assist researchers and evaluators to determine the level of diversity in the program from start to finish, and diversity of alumni that remain in the teaching force. Information on the nature of the curricula and its implementation is essential to understand the nuances of the Noyce programs. This will assist evaluators as well as stakeholders to understand and develop successful program design.

Our review of the evaluations of Noyce programs indicated an overall positive effect of the NSF Noyce teacher preparation programs in preparing STEM teachers for high need schools. We recommend continued evaluations of Noyce programs and availability of evaluation reports for further review and research.

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