Report IV:

Summative Evaluation of the CSUB Robert Noyce Scholarship Program*

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Summative Evaluation of the CSUB Robert Noyce Scholarship Program

Abstract

Over the past five years, California State University, Bakersfield (CSUB) recruited 39 Noyce Scholars for STEM teacher preparation in high-needs schools. As of April 1, 2014, the program has saved approximate $150,000 of NSF funding for this grant. In this summative report, program effectiveness has been examined in three aspects, *Noyce Scholar recruitment, institutional support for teacher preparation*, and *the concurrent impact on high-needs schools*. The evaluation design conforms to a well-established model of Results-Based Accountability to address nine questions: (1) How much has been done in student recruitment? (2) How well did the program perform in student recruitment? (3) Did high-needs schools benefit from the Noyce Scholar recruitment? (4) How much has been done to meet STEM teacher requirements? (5) How well did the program do to enrich STEM learning opportunities? (6) Did the program benefit teacher preparation in high-needs schools? (7) How much has been accomplished in program support? (8) How well did the program do in grant administration? (9) Did the program benefit student learning in high-needs schools? Professional standards in teacher education have been incorporated to facilitate the triangulation of quantitative and qualitative data from Noyce Scholar surveys, interviews, and transcript analyses. Three recommendations are adduced to support teacher preparation during the no cost extension**.**

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California State University, Bakersfield (CSUB) received funding from the *NSF Robert Noyce Scholarship Program* (Phase I) to increase the number of teachers with strong science, technology, engineering, or mathematics (STEM) content knowledge in high-needs schools (NSF Grant No. DUE-0934944). The program offers $10,000 per year for up to two years, and the scholarship recipients are expected to meet teaching requirement upon completion of their single-subject teaching credential.

Over the past five years, the program has supported 39 Noyce Scholars through three options of STEM teacher preparation:

Option 1: Development of Single Subject Matter Competency in mathematics after completing a bachelor degree and a fifth-year program in teacher preparation;

Option 2: Establishment of subject competency in natural sciences by passing the California Single Subject Examination for Teachers (CSET);

Option 3: Completion of a four-year blended program in mathematics for teacher certification.

Annual reports have been filed to NSF to monitor performance of the CSUB Noyce Program since 2011 (see Wang, 2011, 2012, 2013). In these documents, quantitative and qualitative measures were analyzed using a *Context*, *Input*, *Process*, and *Product* (CIPP) model to assess what works, for whom, and in which context. Beyond the formative evaluation for program improvement, this final report places more emphases on the cumulative outcomes since the program inception, and thus, a Results-Based Accountability (RBA) model has been adopted to guide the information gathering in 2014. The evidence collection conforms to the evaluation

guidelines for program accreditation in teacher education (Council for the Accreditation of Educator Preparation, 2014; National Council for Accreditation of Teacher Education, 2008).

Literature Review

According to Aspiren (2014), "Central to the RBA approach is the recognition of two different sorts of accountability which are often confused" (p. 1). *Population accountability* is one of the accountability paradigms to address the local needs. Kern County is located in the southern part of California Central Valley that has a large portion of traditionally underserved population (Wang, 2014). At the seat of Kern County, Bakersfield has been ranked as one of the least educated metropolitan areas in the United States (Zumbrun, 2008).

The overall quality of education was inevitably reflected on teacher preparation. At the beginning of the CSUB Nocye Program, Kern County encountered severe issues of teacher shortage in STEM fields (Gebauer, 2009). It was revealed in an evaluation report that several Noyce Scholars learned mathematics from Physical Education teachers during their high school years (Wang, 2011). Many schools cut STEM education labs during the recent economic recession. Hence, the CSUB Noyce Program represents an opportunity to reverse the trend and improve the quality of student learning in high-needs schools.

In supporting confirmatory research for summative evaluation, Horsch (1996) employed the RBA model to address population accountability for a Harvard education project. She acknowledged the importance of program improvement through systematic evaluation:

> Accountability systems should be designed to support organizational learning and program improvement, not just to report results. Using accountability systems only to report results severely underutilizes their potential. When data are collected because program staff find the information necessary to their work and results information is fed back into the organization to improve its operations, accountability systems are much more valuable and are far more likely to be sustained. (p. 2)

To sustain program improvement, Friedman (2011) clarified that "Population accountability belongs to partnerships" (p. 4). In the CSUB Noyce Program, broad-based partnerships have been established with local schools and community colleges to enhance program effectiveness. As indicated in the original proposal, an advisory board was composed of all faculty mentors, the Deans of *School of Natural Sciences and Mathematics* and *School of Social Sciences and Education* at CSUB, as well as their counterparts at Bakersfield College and Antelope Valley College. Additional support has been solicited from school principals and experienced teachers in Kern County schools. The program also involved experts from other CSU campuses who have implemented Noyce scholarship programs in the past. As a result, a number of proven strategies have been adopted for teacher preparation, including academic mentoring, targeted advising, and induction support (Wang, 2011). Through the partnership building, internship opportunities were extended to Noyce Scholars each summer with support from CSUB and a local museum.

Besides *population accountability*, the other component of RBA is *performance accountability*. In his original work that summarized the RBA model, Mark Friedman (2006) adduced three questions to highlight the key points of performance accountability:

1. How much did we do?
2. How well did we do it?
3. Was anyone better off?

Duncan (2014) provided general indicators for each of the questions pertaining to performance accountability. Following that template, the CSUB Noyce Program has documented the corresponding answers to each of the accountability questions:

1. How much did the program accomplish?

– The program provided adequate preparation of STEM teachers.

2. How well did the program do?

   – The program has implemented the original plan in a cost-effective way. No cost extension has been requested to sustain the program effectiveness.

3. Was the scholarship recipient better off?

   – All Noyce scholars are either within the program or working at high-needs schools, suggesting a 100% rate of placement on both tracks.

While the RBA model is useful in guiding the evaluation design, the Noyce scholarship program is specifically focused on STEM teacher preparation, and the Council for the Accreditation of Educator Preparation (CAEP) (2014) established *adequacy*, *clarity*, and *convincing* criteria on evidence gathering for program evaluation. In this report, adequacy of the program evaluation is addressed across three aspects of *Noyce Scholar recruitment, institutional support for teacher preparation*, and *the concurrent impact on high-needs schools*. The clarity criterion is observed by alignment of the evaluation findings with the afore-quoted three questions from the RBA model. The convincing factor is addressed through triangulation of both quantitative and qualitative data from Noyce Scholar surveys, interviews, and transcript analyses. Therefore, the report design has conformed to the CAEP criteria to assess the impact of the CSUB Noyce Program according to the model of results-based accountability.

Summary of Evaluation Findings

A goal of the NSF Noyce Scholarship Program is to recruit professionals with strong STEM backgrounds who might otherwise not have considered a career in K-12 teaching[1]. In

[1] http://www.nsf.gov/pubs/2013/nsf13526/nsf13526.htm

addition, the program seeks to inspire institutions of higher education to develop and sustain a culture where successful STEM students, including those of the highest achievement and ability, are encouraged and supported when they express a desire to pursue K-12 teaching careers in mathematics and science. Accordingly, Noyce Scholar recruitment and support are identified as the primary foci of this report.

Effectiveness of Noyce Scholar Recruitment

Q1: How much has been done in student recruitment?

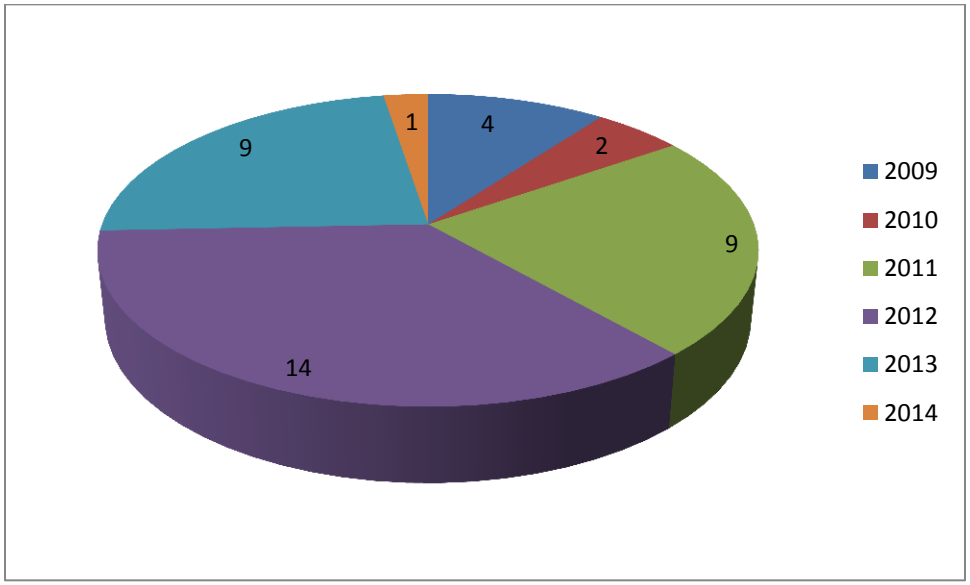
Since the 2009 Fall Quarter, CSUB has partnered with community colleges to recruit Noyce Scholars through five approaches:

1. A Robert Noyce Scholarship Program webpage has been created at the CSUB website and maintained by the principal investigator;
2. CSUB faculty members and the principal investigator made outreach efforts to keep the Noyce Scholarship program visible at community colleges;
3. Flyers and brochures were distributed across CSUB, Southern California Community Colleges, and the cyberspace;
4. The P.I. and Co-P.I.s made presentations at meetings of student societies and clubs;
5. Noyce faculty promoted the program at regularly occurring events such as career fairs, financial aid workshops, and science competitions in this region.

The recruitment effort was demonstrated by Noyce Scholar responses. Interview results confirmed the availability of program information from websites, university advertisements, campus e-mails, program brochures, and hallway posters. Noyce Scholars also found the scholarship offerings from the director and coordinator of the program, community college advisors, STEM professors, and other classmates at CSUB.

As a result, CSUB has met its target of preparing 39 Noyce Scholars according to the original grant proposal (NSF Proposal No. 0934944). Figure 1 shows the number of scholars entering the CSUB Noyce Program during 2009-2014. The longitudinal pattern indicates that nearly 36% of Noyce Scholars were recruited in 2012. While the recruitment is still ongoing in 2014, competitiveness of the program application has increased in the past two years. In 2013, nine STEM students were accepted by the program, which exceeded the average quota for that year.

Figure 1: Noyce Scholar Recruitment



Q2: How well did the program perform in student recruitment?

It was indicated in the NSF proposal that "This program will contribute to the knowledge of how to best recruit, prepare and retain teachers in the science, technology, engineering, and mathematics (STEM) fields" (Proposal No. 0934944). In expanding the recruitment effort, the CSUB Noyce Program hired a program coordinator (Andrea Medina) in 2010 to directly work with STEM majors who have shown strong interest in K-12 teaching. The coordinator enhanced

the capacity of service coordination with three other programs in STEM education[2]. As a result, Figure 1 shows a substantial increase in Noyce Scholar recruitment in 2011. Hence, **one of the useful strategies revealed from this program is to integrate recruitment strategies through well-coordinated office support**. For instance, one of the related programs was the Math and Science Teacher Initiative (MSTI) funded by the CSU Chancellor's office. The information exchange with MSTI students has facilitated Noyce Scholar recruitment. During the interview, one scholar even questioned why she could not receive concurrent supports from both MSTI and Noyce programs.

The CSUB Noyce Program was also quick at incorporating evaluation feedback to strengthen the recruitment effort. In the first evaluation report, four recommendations were adduced to increase the program acceptance rate (Wang, 2011):

1. Probationary Acceptance

For those candidates with GPA slightly below 3.0, careful screening can be conducted to grant probationary acceptance under a condition of improving the GPA above this threshold with in one quarter.

2. Pipeline Expansion

CSUB received other external grants for talent search and STEM education in the past. The Noyce program can benefit from collaboration with the existing STEM education programs to expand the pipeline for student recruitment.

3. Noyce Scholar Profiling

This suggestion was backed by interview results that suggested appreciation of Noyce Scholar recognition during public events, such as graduation ceremonies.

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[2] see program sits at www.csub.edu/mti, and www.csub.edu/crest, and www.csub.edu/stem.

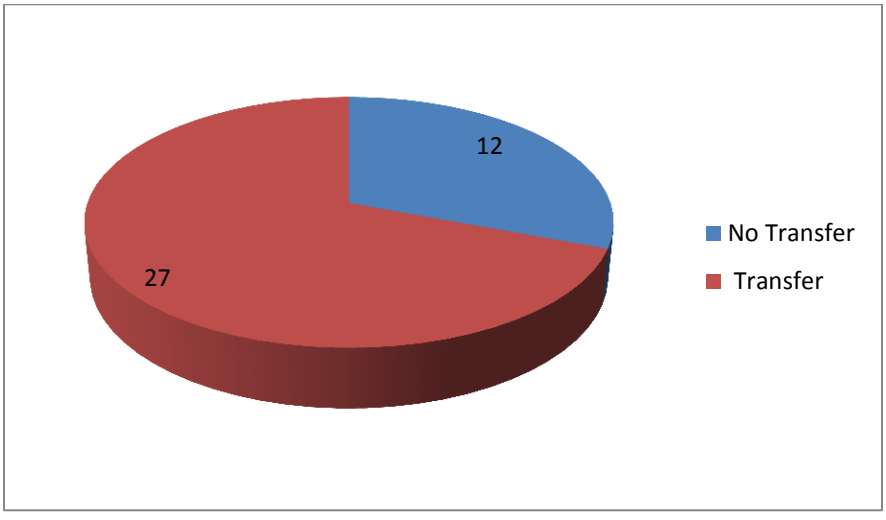
4. Interdisciplinary Recruiting

The program may successfully recruit Noyce Scholars who transferred to STEM majors from other subjects, such as history, accounting, nursing, and political science.

In the following year after addressing these recommendations, it was found that "The Noyce Scholarship program has met its recruitment target" (Wang, 2012, p. 23). Hence, **the second effective strategy exposed from the program evaluation is to institute improvements according to the report feedback**.

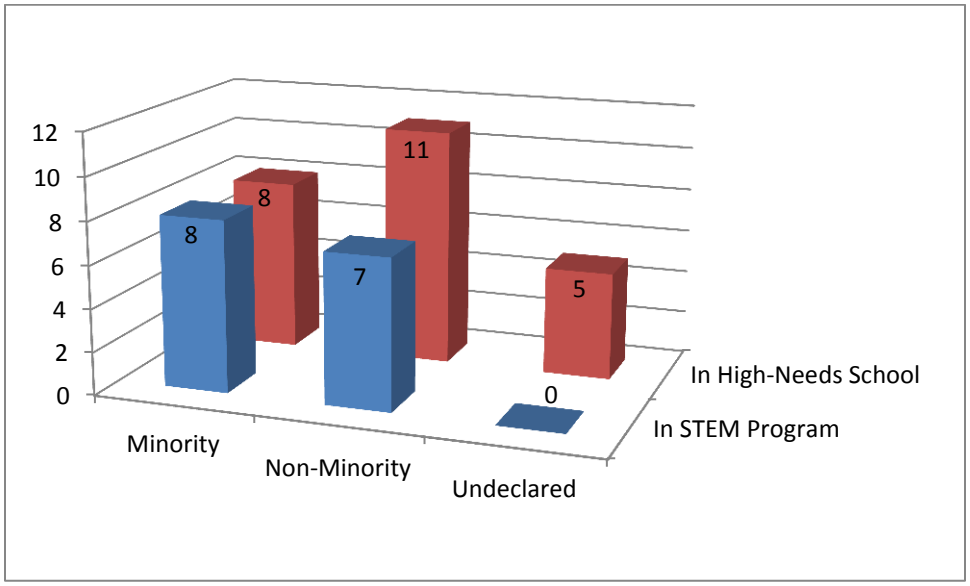
Furthermore, transcript analyses in 2014 indicated that nearly 70% of the Noyce Scholars transferred courses from community colleges to CSUB (Figure 2). Thus, **the third strategy for Noyce Scholar recruitment is to strengthen the partnership between CSUB and community colleges**. As was indicated in the original proposal, the review panel for Noyce Scholar recruitment included the principal investigator, four co-principal investigators, and two community college faculty members. Because CSUB and Antelope Valley College were designated as Hispanic serving institutions, the partnership building has ensured representation of minority groups in the Noyce Scholar pool.

Figure 2: Categorization of Transfer Status for Noyce Scholars



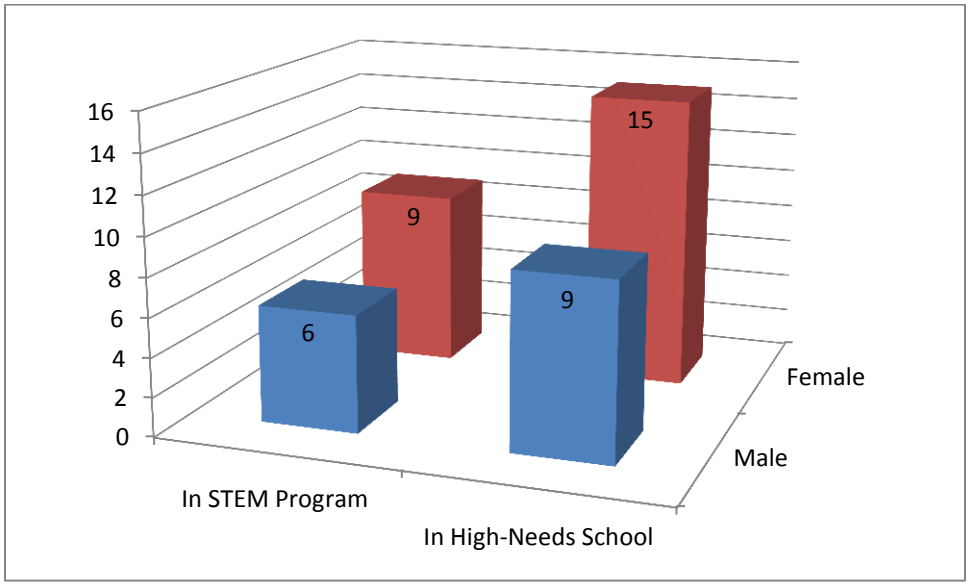
In the CSUB grant proposal, it was promised that "Each year, two new awards will be reserved for minority or underrepresented gender applicants or persons with disabilities, unless there are no eligible applicants." Figure 3 shows the ethnic distribution of Noyce Scholars on two tracks, (1) these already entered the teaching phase in high-needs schools, and (2) those remaining in the STEM teacher preparation programs at CSUB. The results indicate an increase of minority representation from 33% in the teaching group to 53% in the STEM teacher preparation group. The teacher preparation group was recruited after the group already teaching at high-needs schools. Thus, the results indicate that the CSUB Noyce Program has maintained the momentum of exceeding the recruitment target for minority scholars.

Figure 3: Ethnic Distribution of Noyce Scholars



Meanwhile, Frean (2007) suggested the need of recruiting female teachers in STEM fields. Figure 4 shows recruitment of more female students in the Noyce Scholar pool. Therefore, the existing recruitment approaches have maintained both quality and diversity of Noyce Scholars in the CSUB program.

Figure 4: Gender Distribution of Noyce Scholars



Q3: Did high-needs schools benefit from the Noyce Scholar recruitment?

Researchers found that "One of the most confounding working conditions problems in high-needs schools is out-of-field teaching" (Berry, Daughtrey, & Wieder, 2009, p. 8). While the NSF Noyce program addressed the subject competency issue in STEM education, the long-term impact hinges on retention of Noyce Scholars after completing their teaching commitments in high-needs schools.

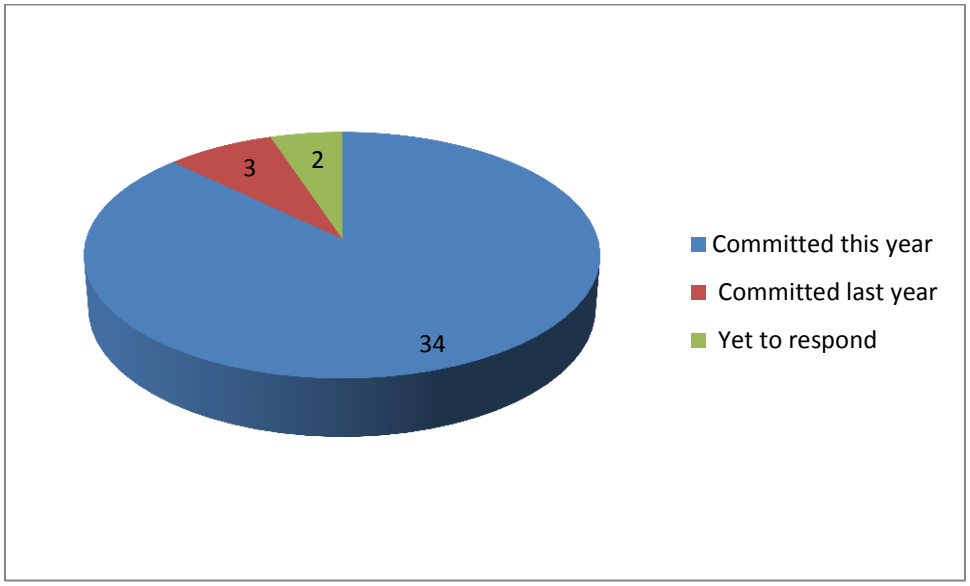
It was noted in the CSUB grant proposal that "most teachers choose to teach at schools that are close to where they were raised or went to college" (p. 12). Thus, teacher retention has been considered in Noyce Scholar recruitment to "increase the chances of the students to become a teacher in the Kern County High School District" (NSF Grant No. DUE-0934944, p. 15). The recruitment consideration has benefited high-needs schools on three fronts:

1. Commitment to Working at High-Needs Schools

An analysis of the survey data from Noyce Scholars indicated that most respondents expressed their desire to stay at a high-needs school after completing their teaching contracts (Figure 5). The decision was reconfirmed by interview responses this year. The following answers were repeatedly provided by Noyce Scholars during the data collection:

> I plan on teaching in a high-needs school for my whole career.
> I do not foresee ever teaching anywhere but the site I am at.
> If I am needed in a high needs school district then that is where I will be.
> As long as I continue teaching it will be in a high needs school. I will not apply to schools of high-income areas even after my 4-year commitment for Noyce has ended.

Figure 5: Noyce Scholars Willing to Continue Teaching at High-Needs Schools



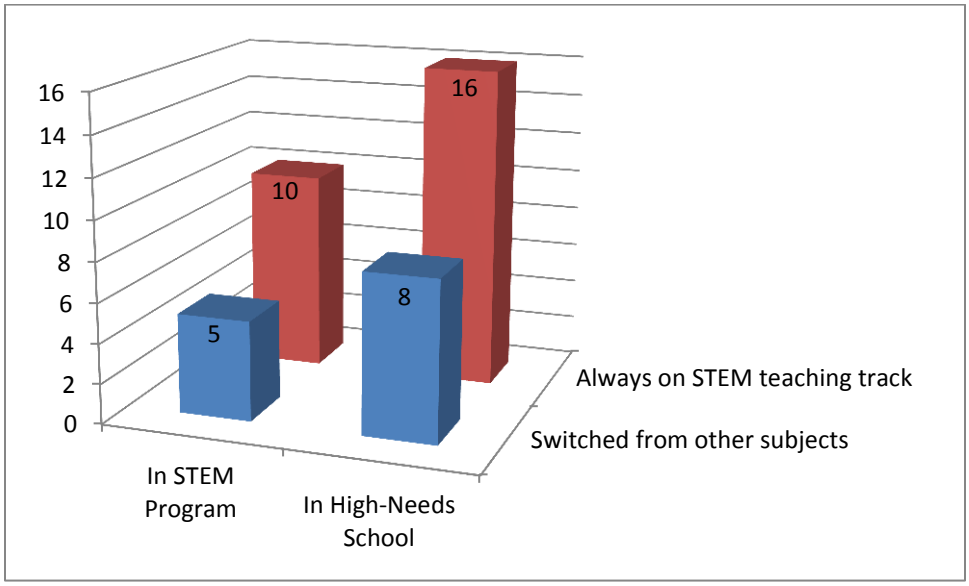
2. Recruitment of Teachers from Other Professional Fields

In addition to targeting on STEM majors, NSF Noyce Scholarship Program was designed to attract STEM professionals into the teaching force and use their services to improve high-needs schools[3]. Over the past five years, CSUB has encouraged and supported successful STEM students to pursue K-12 teaching careers in mathematics and science. In the current

[3] http://www.aps.org/units/fed/newsletters/spring2009/prival.cfm

Noyce Scholar pool, one third of the scholars used to major in a non-teaching track (Figure 6), and thus, the talent recruitment played an important role in the CSUB Noyce Program

Figure 6: Past Experiences of Noyce Scholars

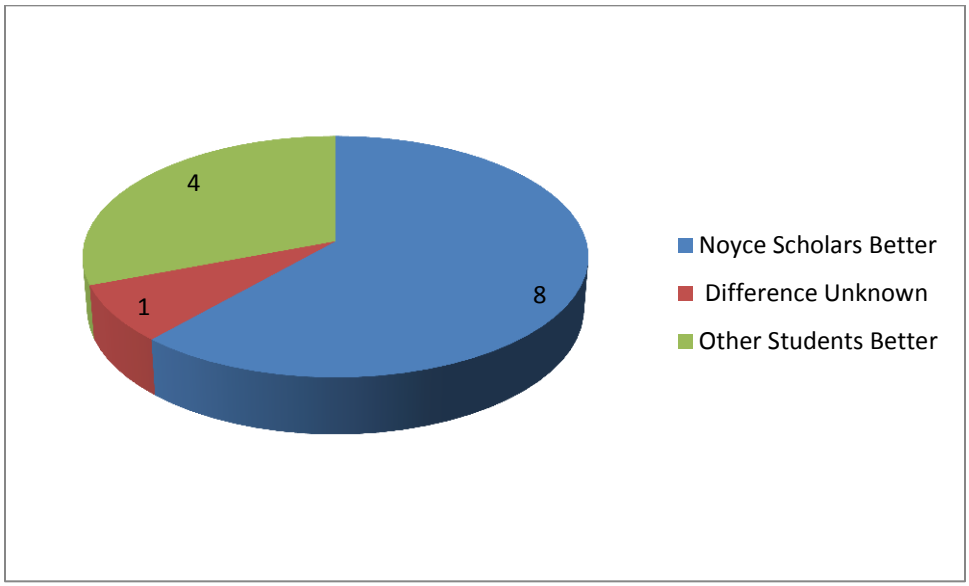


Interview results indicated the success of recruiting Noyce Scholars from a non-teaching track. One scholar reported that "initially I wanted to go into some type of medical field. However, I realized that teaching was my calling with support from the Noyce program." Another scholar concurred that "I thought about becoming a researcher and working in the industry as a scientist under medical companies." If it was not because of the Noyce Scholarship Program, another scholar indicated that "I planned on graduating with a BS in Chemistry and then go from there trying the industry." The recruitment of STEM professionals has directly enhanced subject competency of science and mathematics teachers in high-needs schools.

As Richtmyer (1933) pointed out, "The teacher, say, of science, must remember that though as a teacher he may be an artist, he is at the same time a scientist. He must approach the subject matter in his field always in the latter capacity" (p. 3). The CSUB Noyce Program has

recruited Noyce Scholars with strong subject competency, which ensured the quality of STEM education at high-needs schools. Figure 7 shows a comparison of subject competency between Noyce Scholars and other STEM majors not on the teaching track. The data were gathered from 13 Noyce Scholars working toward their program completion at CSUB. Most respondents indicated stronger academic preparation for Noyce Scholars.

Figure 7: Comparison of Preparation Between Noyce Scholars and Other STEM Majors



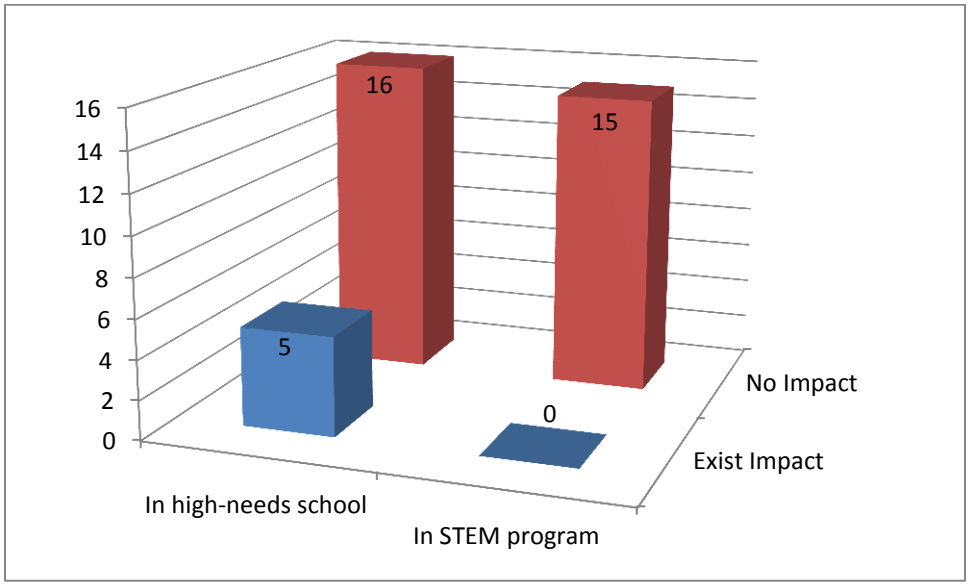
It should be noted that the funding period occurred during economic recession, which made some STEM students indecisive about their career choice. One scholar acknowledged that "I have considered other careers that would use my Biology degree, but I have not actively pursued those careers. It has been more of an awareness of what is available, especially when the budgets were so unstable." Although oil industry, business analysis companies, and statistical consulting services were cited by Noyce Scholars as alternative career opportunities, the decision to become a STEM teacher was deeply rooted in personal preference. A scholar

reported, "Past experiences, such as working for the *California Mini Corps* program drove my decision to become a teacher in a high-need school."

3. Establishment of Intrinsic Motivation for STEM Teaching

Researchers has long found that the choice of STEM teaching was influenced by individual motivations (Brookhart & Freeman, 1992), for which "highly persistent" teachers placed more emphasis on intrinsic rewards (Lawrenz & Kirchhoff, 2009; Watt & Richardson, 2008). Although the Noyce scholarship was an important factor to support extrinsic motivation, most scholars indicated that they would eventually choose to be a math or science teacher regardless of the scholarship (Figure 8).

Figure 8: Scholarship Impact on Scholars' Decision to Become a STEM Teacher



One Noyce Scholar recalled the decision process. She noted that "I majored in Political Science with aspirations to go to law school, and I have to say that my main motivation was to make a lot of money. After working in a law office for a couple years, I realized I would be

happier following my original dream of teaching." Researchers found that the self-fulfillment can facilitate teacher retention at high-needs schools (Berry, Rasberry, & Williams, 2007).

In summary, effective recruitment strategies have been adopted by the CSUB Noyce Program to attract a *large*, *diverse*, and *quality* pool of candidates for STEM teacher preparation. As of April 1, 2014, the program has already met its target of recruiting 39 Noyce Scholars for this grant. Positive characteristics of the Noyce Scholar pool are not only represented by subject competency and demographic diversity, but also indicated by their strong commitment to a long-term teaching career at high-needs schools.

Support for STEM Teacher Preparation

Q4: How much has been done to meet STEM teacher requirements?

Multiple tracks of teacher preparation have been created to support STEM education at CSUB. More specifically, a Bachelor of Arts degree has been offered in Natural Sciences across departments of Biology, Chemistry, Geology, and Physics to meet the requirement of subject matter competency in California Subject Matter Examinations for Teachers (CSET). Besides the primary concentration, Noyce Scholars must choose another science domain as their minor and complete cognates in Mathematics and Astronomy. To enhance the integration of student learning, STEM faculty jointly worked on the course design to address all three components of CSET, two on general knowledge of science and one on a primary concentration in Biology, Chemistry, Earth/Planetary Science, or Physics. The program development supports the CSET passage for candidates' entry to a teacher credential program at CSUB.

An alternative route to establish science competency is through completion of a B.S. degree in Biology, Chemistry, Geology, or Physics. To smooth the transition from STEM training to teacher preparation, Dr. Ron Hughes, a science educator, switched his affiliation from *School of Social Sciences and Education* to *School of National Sciences and Mathematics*. Additional learning opportunities have

been created for Noyce Scholars from outreach efforts. For instance, one scholar recollected, "The speakers Dr. Hughes brought to the Noyce meetings shared rich information and I feel like the insight I gained will strengthen me as a teacher." The network support has surpassed the regular call of duty. Another scholar reported,

> I really enjoyed a dinner that was hosted by Mr. Ron Hughes at his house. It was wonderful getting to know faculty members, as well as a retired teacher from the Kern High School District. The connections to individuals who can offer advice has been the most beneficial.

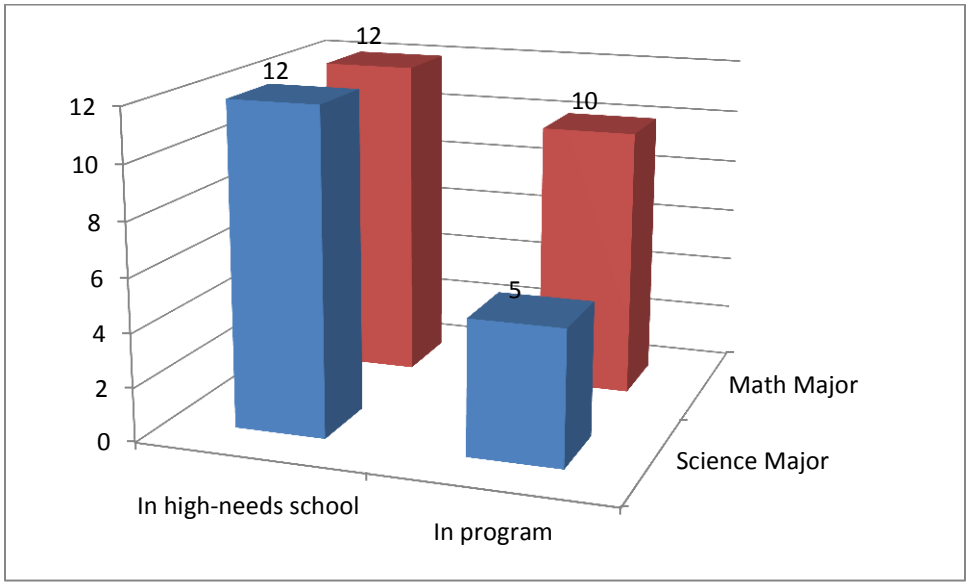
Meanwhile, faculty members constantly promoted the CSUB Noyce Program as a great opportunity for students. For example, one scholar wrote that "The program was suggested to me by one of my professors (Carl Kloock)." While teaching in the department of biology, Dr. Kloock has extensive involvement in education. In 2011, he was recruited as a faculty member of the Ed.D. program at CSUB. The interdisciplinary support has created an institutional culture to encourage and support successful STEM students who desired to become a science teacher.

In mathematics, CSUB faculty routinely revised the local curriculum to reflect the most recent standards from California Commission for Teacher Credentialing (CCTC). For instance, the program has updated its *philosophy and purpose* and incorporated adequate consideration of *diversity and equity, technology, literacy, pedagogies, early field experiences, advisement and support, program review and evaluation, coordination,* and *content standards*. As a result, a bachelor degree in mathematics automatically satisfied the Single Subject Matter Competency for teacher preparation.

In addition, a blended program in mathematics provided a new route to complete both subject training and teaching credential within four years (i.e., 196 quarter units). "Most campuses in the CSU system don't have this blended program and students must spend five years to accomplish their undergraduate studies to become a math teacher" (Popa, 2008, p. 9). In evaluating effectiveness of Noyce scholarship programs across the nation, Liu, Johnson, and

Peske (2004) reported that the speed of training and the quick entrance to the classroom were more important than money in recruiting individuals to teaching. Therefore, the CSUB Noyce Program is modeling after the best practice in teacher education. Altogether, the program has attracted an equal number of science and mathematics teachers to work at high-needs schools (Figure 9). For scholars remaining at the stage of STEM training, Figure 9 further indicated more mathematics majors in the Noyce Scholar group. Therefore, the blended program in mathematics might seem more appealing to new Noyce Scholars.

Figure 9: Noyce Scholar Distribution across Different Stages of Teacher Preparation



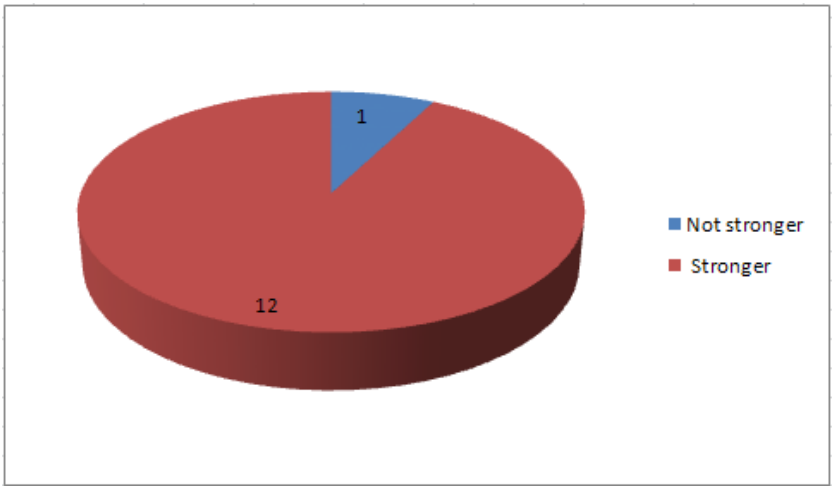
Q5: How well did the program do to enrich STEM learning opportunities?

The CSUB Noyce Program has retained a group of award-winning faculty to support STEM teacher education. In particular, the Principal Investigator, Andreas Gebauer, was the awardee of CSUB Faculty Leadership and Service Award in 2010. Another Noyce Advisor, Dirk Baron, won the CSUB Faculty Research Award in Academic Year 2010-11. The Associate Dean, Kamel Haddad, also played an active role as a Noyce Scholar advisor. He was a recipient of the

Millie Ablin Excellence in Teaching. Carl Kloock directs a Master Program in Science Education with a grant award from the National Science Foundation. Through his professional leadership, Robert Noyce Teacher Fellowships have been made available to enhance the quality of STEM teachers in Kern County.

Built on the faculty resources, mentor assignments have been made for Noyce Scholars upon their program entry. Every tenure-track faculty member in the School of Natural Sciences and Mathematics is expected to teach courses on the teaching track. Accordingly, a tight-knit group has been organized to support a community of learners in the pipeline of STEM teacher preparation. Noyce Scholars are granted regular accesses to Noyce Advisors, the Principal Investigator, Co-Principal Investigators, and other faculty members in STEM education. In comparison to their peers on the STEM track, nearly all Noyce Scholars within the STEM programs indicated a stronger connection with science and mathematics faculty (Figure 10).

Figure 10: Noyce Scholar Connection to Science and Mathematics Faculty



Noyce Scholars further acknowledged extra learning opportunities from the CSUB Noyce Program. One scholar noted,

> Being a Noyce scholar helped me add an important asset to my resume, assisted me in attending several workshops including NSTA regional conference in Portland, OR, and helped inform me about many different resources available to science teachers. Conferences I attended as a result of being a Noyce scholar included constructing inquiry-based curriculum, applying for grants to allow students to gain field experience, implementing common core activities, and many other valuable components that I plan on using in my teaching career.

Another scholar concurred that "The Noyce scholarship meetings always provide me with real life input from successful teachers, which give me learning experiences."

The program support has directly enhanced skills of Noyce Scholars who are teaching at high-needs schools. One of them noted that "I participated in the STAR Summer Research Program because I am a Noyce scholar. I learned about computer programming and how to incorporate part of my research in a lesson plan to share with my students." Another respondent indicated,

> Because I am a Noyce scholar I had a wonderful opportunity to participate in the STAR program last summer. It was an amazing experience where I worked at The Air Force Research Laboratory on self-healing polymers, specifically mechanophores. I learned so much at the Air Force Research Laboratory about chemistry and other applications that I could apply into the classroom.

The summer internship has a limited number of spaces. A scholar reported that "I feel that if it weren't for Noyce, I wouldn't have been accepted into the program." Meanwhile, STEM faculty members were deeply involved in these extra-curricular activities. For instance, the interview results revealed that "The study sessions with Dr. Haddad were extra and extremely helpful." In conclusion, it was the combination of quality faculty, rigorous curricula, and additional learning opportunities that sustained the support for STEM learning at CSUB.

Q6: Did the program strengthen teacher preparation in high-needs schools?

In comparison to other programs in teacher education, the Noyce scholarship program fulfills a clear goal of preparing STEM teachers for high-needs schools. To reach that goal, a

profound gap should be recognized in the institutional settings between CSUB and a high-needs school. For instance, a scholar noted that "Nothing we learned in the programs can adequately prepare us for the transition from academia in a collegiate setting to being in a high needs classroom. The cultural difference between those two worlds is far too great."

Consequently, field-based training has been emphasized by the current standards for program accreditation in teacher education. Based on the national standards, *knowledge of teaching* consists of three components, *content knowledge, pedagogical content knowledge* and *pedagogical knowledge* (National Council for Accreditation of Teacher Education, 2008). To support this summative evaluation, evidence has been collected from Noyce Scholar surveys, interviews, and transcript analyses to examine the three-fold knowledge development for these upcoming teachers at high-needs schools.

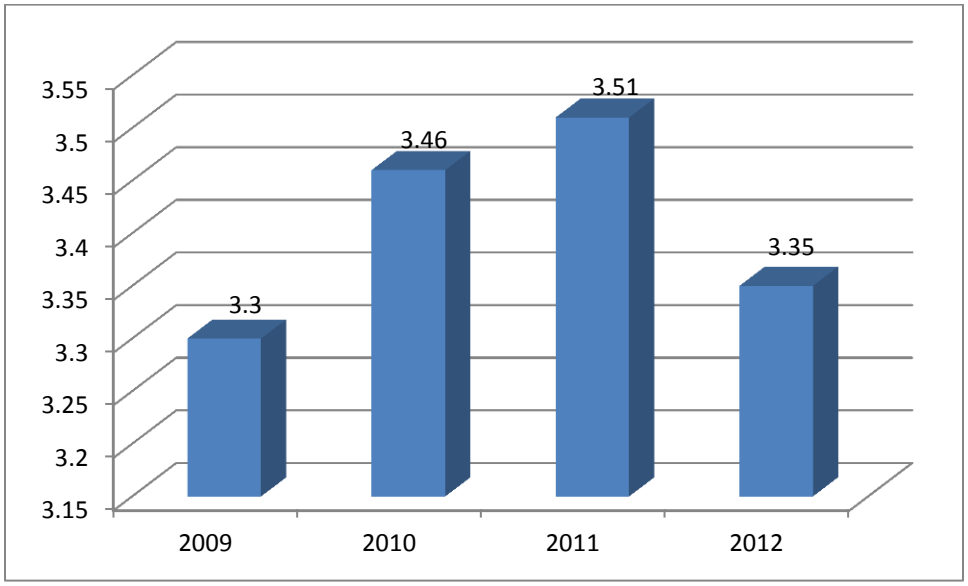
1. Content Knowledge Preparation

Noyce Scholars gained their content knowledge from CSUB professors who earned terminal degrees in the STEM fields. One Noyce Scholar noted,

> From the perspectives of content-knowledge, teaching pedagogy, and/or classroom management, I believe that the most positive and helpful aspect of my program in general is the content-knowledge. The content-knowledge from this program is strong because the content that we receive in the classroom suits what we will be facing as new teachers once we graduate the university.

Although the program set a 3.0 GPA criterion for candidate recruitment in the original proposal, the final average GPA has reached a level above 3.4. The transcript analyses also revealed a significant difference between the Noyce Scholar group and regular students at CSUB on the GPA indicator [$t(38)=12.20$, $p<.0001$]. Figure 11 shows the pattern of average GPA for Noyce Scholars at the program entry. The results reconfirmed compliance of the 3.0 GPA criterion for subject competency.

Figure 11: Trend of the Average GPA of All Noyce Scholars at the Program Entry



2. Development of Pedagogical Content Knowledge

Pedagogical Content Knowledge (PCK) is defined as "The interaction of the subject matter and effective teaching strategies to help students learn the subject matter" (National Council for Accreditation of Teacher Education, 2008, p. 89). Noyce Scholars acquired PCK from extensive field experiences in STEM classrooms. One scholar stressed that "The most helpful aspects of my program are the required observation hours and courses specifically designed for future high school math teachers." In science, another scholar agreed that "I really enjoyed observing a science classroom at Tevis Jr. High School."

For Noyce Scholars currently fulfilling their teaching commitments, the following responses represented a good reflection across the entire group – "Honestly, the most helpful aspects that aided me in teaching in a high-need school were from conversing with teachers at the site and from hands-on experiences, which includes sometimes failures and successes." To

address this need, the PCK development was carried out systematically in the CSUB Noyce Program. As one scholar testified,

> The Credential Program at CSUB required me to step inside a classroom before I had a classroom of my own. During this time, I noticed some of the challenges I would face in my own classroom. I gained ideas from other teachers and my professors in the credential program.

The PCK development has enhanced professional dispositions for STEM teaching at high-needs schools. One scholar indicated, "I learned to be patient with my students and that all students have the capability to succeed." The following responses illustrated their benefit from this program to help engage students in active learning at high-needs schools:

> The most positive aspect of the program would be the motivation of doing well in school, which will further on in motivation to do well in schools while teaching.
> Keeping the student's motivated, engaged, and connected with mathematical concepts wh ile maintaining a healthy learning environment.
> Because there is large verity of personalities in each classroom, we need to learn how to maintain an encouraging, respectful and welcoming atmosphere.
> Learning and discussing about classroom management techniques and different teaching strategies were the most helpful aspects of the teaching program that prepared me for my own classroom.
> The most helpful aspects in preparing me were that I was able to meet and be around a community of teachers who wanted to do the same thing as me.
> Learning classroom management strategies and discipline models for the classroom has been valuable. These help me run my classroom smoothly and increase the amount of time I can spend on instruction without other unnecessary distractions.

3. Pedagogical Knowledge Improvement

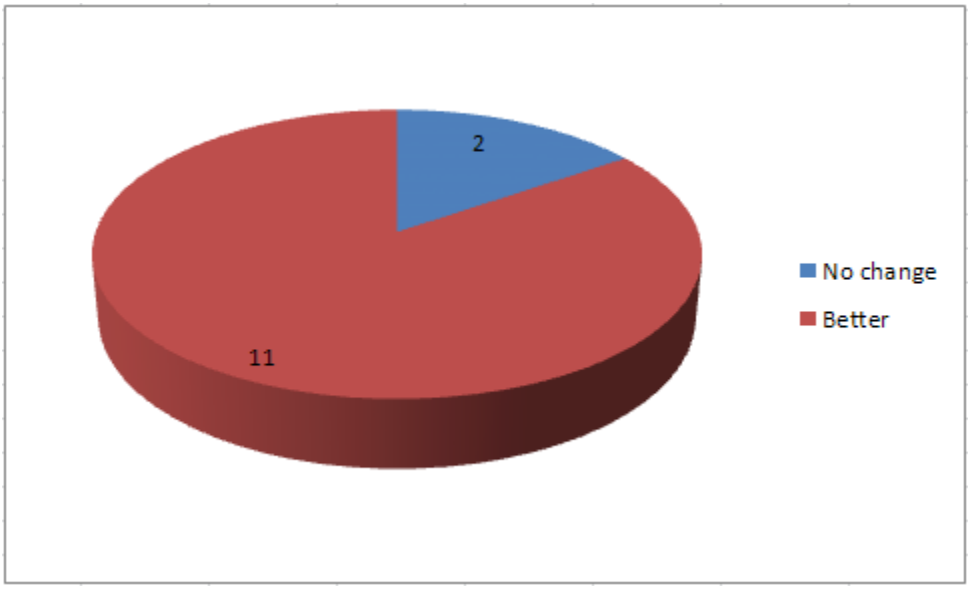
Pedagogical Knowledge was defined as "The general concepts, theories, and research about effective teaching, regardless of content areas" (National Council for Accreditation of Teacher Education, 2008, p. 89). One particular challenge for most Noyce Scholars is an impending implementation of the Common Core Curriculum (CCC) at high-needs schools. One Noyce Scholar observed that "Common Core is a big push happening in many schools." The

CSUB Noyce Program has incorporated CCC preparations to address the future demand. This program feature was recognized by Noyce Scholars during the interview:

> The most helpful aspects of the program is that it helps us understand common core standards. Since common core is new to us the program helps us understand the content so that we could in turn be successful in helping the students be critical thinkers and problem solvers.
> I see the common core standards as a welcomed change. Going to the STEM conference I learned about what the changes are and how to implement them into the classroom. Noyce also taught me that I can make a difference and use my knowledge and desire to be a good teacher to create and research how to improve for me and others.

The quality of learning experiences is indicated by feedback from Noyce Scholars who kept their enrollment in CSUB this year. Most of them indicated better learning experiences in these STEM education programs (see Figure 12).

Figure 12: Noyce Program Impact on Quality of Learning Experiences



In summary, the CSUB Noyce Program has laid a solid foundation to support STEM teaching at high-needs schools. One scholar attested,

> I feel I have received a very well-rounded education at CSUB. I feel very confident in the content knowledge due to the math department, and the credential department has helped me prepare for all the other aspects related to teaching.

Although no program can completely address all issues of STEM teaching at high-needs schools, a Noyce Scholar indicated that "I enjoy the challenge of researching the best strategies to use to meet the learning needs of all my students." With the program support, they are equipped with the three-fold knowledge in STEM teaching. As one scholar mentioned, "When I run into behavior issues I always fall back on the trainings and ideology I was referred to at CSUB which in turn helps me straighten out issues."

Impact of the Program Support

Q7: How much has been accomplished in program support?

The grant administration is supportive of professional collaboration between CSUB and high-needs schools. The Kern County School District is an active participant in the state induction requirement through Beginning Teacher Support and Assessment (BTSA) programs. Noyce Scholars are mentored by BTSA support providers identified from a group of veteran teachers. Faculty in the teacher credential program work closely with BTSA colleagues to ensure a seamless transition for Noyce Scholars from a student-teacher to a regular teacher in high-needs schools. As a Noyce Scholar noted,

> Some of the learning experiences that I have experience as part of the Noyce scholar has been the opportunity to get to know staff from the education department. This gives me the opportunity to get to know the current changes that are undergoing in the California educational curriculum.

The collaborative effort has addressed a critical need for teacher preparation. As one Noyce Scholar noted, "The majority of the schools in the area I live in are considered a high needs school." The program support in the past has alleviated anxiety of Noyce Scholars toward the job transition. As one scholar indicated, "I hope when I finish my degree and credential that I will have assistance in applying for a high school position. I am kind of unsure in the process and I was hoping the Noyce program could assist me."

CSUB has provided administrative support to make the Noyce Program a central institutional focus. To broaden the base for Noyce Scholar recruitment, the Program Coordinator, Andrea Medina, has been authorized to access the candidate pools of other STEM projects, such as Math and Science Teacher Initiative, NSF Center for Research Excellence in Science and Technology, and Chevron Summer Research Program. After Noyce Scholar selections, the central office is in charge of monitoring the program requirements of:

- full-time enrollment (12 units per quarter) at CSUB;
- a total GPA at or above 3.0, including GPA of 2.5 or higher in STEM courses;
- fulfillment of meeting assignments with advisors in the department of their major;
- completion of teaching contract as a STEM teacher in high-needs schools.

Enforcement of the Noyce Scholarship requirements is modeled after successful programs on other CSU campuses. In particular, local Noyce Scholars have joined a MERLOT Community of scholars across the CSU system. In collaboration with colleagues of CSU Fresno, Noyce Scholars participated in face-to-face seminars and webinar workshops to share high-quality, peer-reviewed instructional plans and strategies in secondary mathematics and science education. Online discussions have been arranged to provide beginning teachers with the opportunity to clarify their thinking about complex educational issues and make more informed decisions about their professional practice.

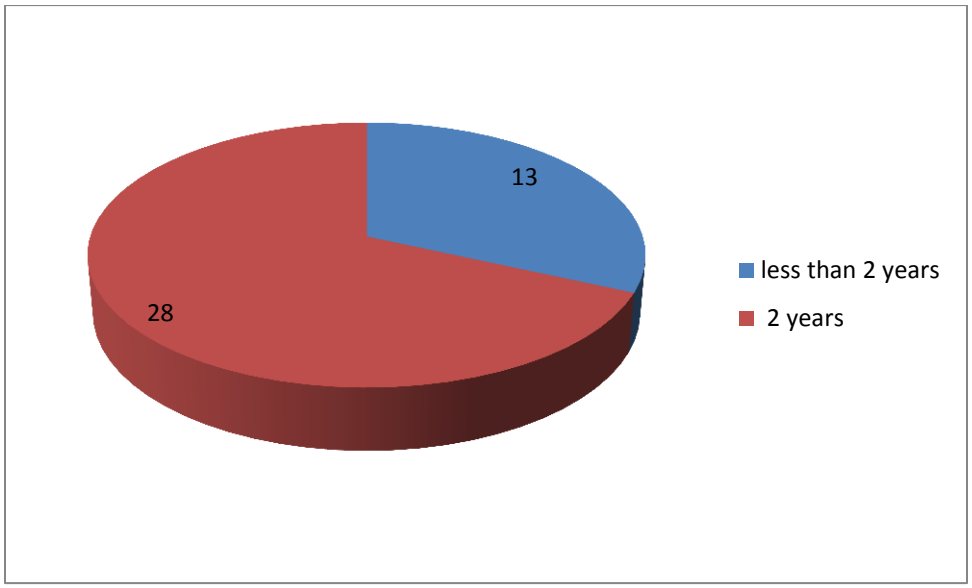
Noyce Scholars valued the practical support highly. For instance, a special benefit identified by one scholar was that "I have been able to attend seminars that will be applied to the enrichment of my students learning." Another scholar concurred that "The contacts and support that are ongoing are the most helpful aspects. I enjoyed learning from each other and sharing ideas." The learning opportunities were offered exclusively for Noyce Scholars. One of them stated that "I had a great many extra opportunities for learning and networking because of the Noyce Scholar status." The capacity building has fostered a sense of camaraderie through the program

coordination, and created a stress-free environment for information exchanges across key stakeholders. Built on an assumption that "the whole could be larger than the sum of its parts", the program support involved partnership development to strengthen preparation of beginning teachers for high-needs schools.

Q8: How well did the program do in grant administration?

In addition to the effort on Noyce Scholar mentoring, the CSUB Noyce Program has incorporated cost-effective measures in grant administration. The NSF funding was designated to support preparation of 39 scholars for teaching positions at high-needs schools. Depending on their contracts, Noyce Scholars may choose to receive one or two years of scholarships. Figure 13 shows the scholarship allocation among all Noyce Scholars since 2009.

Figure 13: Scholarship Distribution among Noyce Scholars



Among the 13 scholars in the "less than 2 years" category, three STEM students took 1.25 years of the scholarship support. Since the scholarship was set at $10,000 per year, the

budget savings from the blue-colored category should reach $122,500. As of April 1, 2014, the program generated additional savings, leaving $150,000 for no cost extension .

Part of the extra $27,500 savings can be tracked back to the strict fiscal measures adopted by the CSUB Noyce Program. For instance, no money was spent on evaluation in the first year when the program did not produce outcome data at the inception stage. Other savings were resulted from the office and personnel sharing with various STEM projects, including Math and Science Teacher Initiative (MSTI), NSF Center for Research Excellence in Science and Technology (CREST), and Chevron REVS UP Summer Research Program.

Effectiveness of the program administration is also reflected by the fact that no staff turnover occurred in the past five years. The office stability facilitated the tracking of Noyce Scholar compliance according to the original contracts. In particular, it was indicated in the grant proposal that "Funds remaining from students who drop out of (or are dismissed from) the incentive program will be redirected to qualified students not funded by the program." Since 2009, a total 41 students have been accepted by the CSUB Noyce Scholarship Program. Two students changed their career plans. One of them received the scholarship for two years and the other received the support for one year. Following the NSF regulation, the money has been converted into student loans to redirect the support for more Noyce Scholars during the period of no cost extension.

The remaining 39 scholars are in full compliance with the program regulations, including the requirement at the teaching stage to provide annual certification of employment at high-needs schools. Noyce Scholars appreciated effectiveness of the grant administration. The following responses were repeatedly obtained during the Noyce Scholar interviews:

> I personally do not believe the program needs any improvement. I have enjoyed my time with Noyce. It has motivated me to get my grades up and work even harder to reach my

> goal. I am already working in a high needs school, so I have some background knowledge of that.
> I have no suggestions for improving my experience. The Noyce program has been an asset to my education.
> I wish I could provide more constructive feedback, but I am very satisfied with the Noyce program. The advisor support, guest speakers, and internships contributed to my rich experience at CSUB, and also provided me the support necessary for me to succeed in my classes.

To some scholars, the CSUB Noyce Program provided an indispensable bridge in their career paths. One scholar noted,

> Being a Noyce scholar I have experienced that I have more respect because it's a prestigious honor. I have also experienced that if I hadn't been able to get the Noyce scholarship, I wouldn't be able to continue in my school at CSUB.

As a result, the following responses were typically expressed during the interview process, "I appreciate greatly the Noyce program and am thankful I could be a part. Financially, it helped me out tremendously." Hence, the program savings were generated without any compromise to the quality of support for Noyce Scholars.

Q9: Did the program benefit student learning in high-needs schools?

The guideline for NSF Noyce Scholarship Program stipulates that "To the extent possible, project evaluation should address teacher effectiveness in terms of the impact on student learning."[4] According to National Council for Accreditation of Teacher Education, "knowledge, skills, and disposition" (KSD) are the number 1 criterion for program accreditation in teacher education[5]. Therefore, the impact of CSUB Noyce Program is evaluated in this section to reflect the benefit for student learning from the KSD aspects of teacher preparation.

1. STEM Knowledge to Support Student Learning

   In high-needs schools, "It is challenging to increase student interest in Math" and

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[4] http://www.nsf.gov/pubs/2014/nsf14508/nsf14508.txt
[5] http://www.ncate.org/documents/boeMaterials/ncate_unit_stnds_%20summary.pdf

"Trained and knowledgeable teachers who can relate the content to students' interests are rarely found in low-income schools." – These comments were made by Noyce Scholars to justify their unique contributions to high-needs schools. With the program emphasis on field-based learning, Noyce Scholars are well-adapted to support student learning in that context. As one scholar indicated, "When I explain a problem to a student, he is happy to understand what the concept is. For this reason, I think that teaching will be a very rewarding position."

The CSUB Noyce Program has provided adequate knowledge preparation. One scholar noted that "I have a lot to bring to students to help teach them, mentor them, and help them." Another scholar reconfirmed her rich STEM knowledge for "Creating lessons that the students can understand and find valuable." The self-assessment results are echoed by positive feedback from students. One scholar reported "Hearing students talk about how much I've helped them." Another scholar elaborate,

> One student has shown me the reason I do what I do. She is a senior. She has "disliked" math for as long as she can remember. She failed algebra in 9^{th}, 10^{th}, and 11^{th} grades. She is in my Applied Algebra class, and due to her hard and perseverance, she earned an "A-" in the first semester. Her confidence has increased tremendously. She is now able to assist others in our class to understand concepts. It is amazing to see the change in her. Also, after tying numerous times to pass the CAHSEE Mathematics, she passed. It has been an amazing year for her and quite the encouragement for me.

High-needs schools also instituted mechanism to document student learning outcomes. One scholar reported that "When the students understand key concepts and retain an understanding of the content, the results were illustrated through various forms of assessments." The instructional focus on special student needs played an important role in the teaching effectiveness. In the end, as a scholar noted, "The students are receptive to the materials because they can relate the science contents to their understanding of the world around them."

Noyce Scholars' contribution is further reflected by the trend of ongoing improvement in student learning experiences at high-needs schools. In the past, a scholar recollected, "These students have been pushed through their whole lives not expected to be earning the credit but just attending. ... The students have noticed I really want them to learn and I love seeing the students respond with 'wow, I finally understand the content in math'!" Although it was a relatively short period for most Noyce Scholars to enter the teaching phase, positive changes have already surfaced from school sites – A scholar reported "seeing how students improved science and math learning outcomes over the course of a few months."

2. Teaching Skills to Strengthen Student Engagement

In addition to STEM knowledge, practical skills are needed to support student learning in high-needs schools. As Frank Richtmyer (1933), a founder of the American Physics Society (APS), pointed out, "That a knowledge of subject matter, however thorough that knowledge may be, is not of itself an entirely adequate preparation for teaching is at once recognized from the fact that there are many excellent scholars who are poor teachers" (p. 1).

At the beginning of their teaching career, Noyce Scholars recognized the importance of developing teaching skills. One scholar indicated that "The lack of student motivation and the lack of time to accomplish all of my learning objectives every quarter are the most challenging aspects." Another scholar delineated,

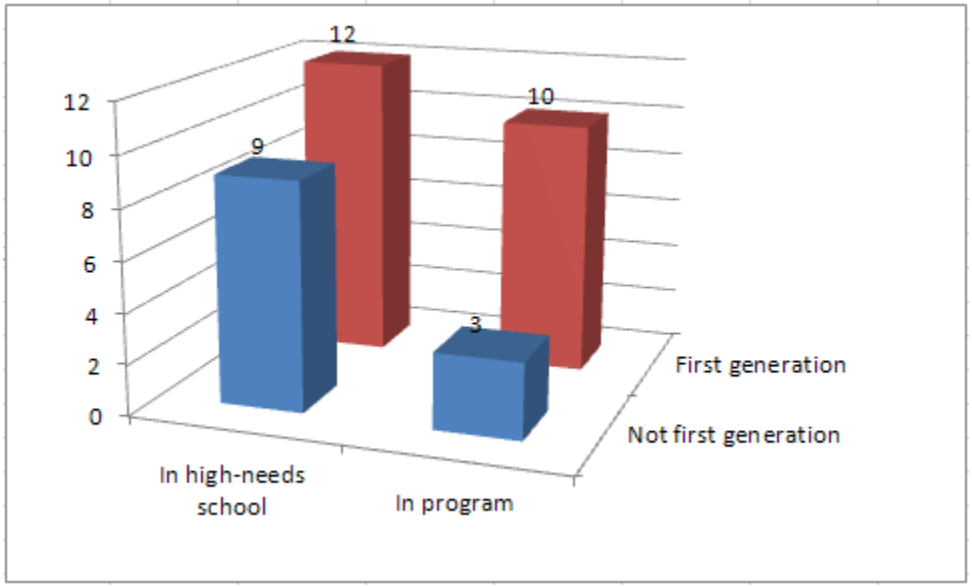
> This is my first year teaching. I work with "at-risk" students in grades 9-12. These students have failed a math class at least once. At the beginning of the school year, I took a survey of all my students, and 85% of them "disliked" math. The challenge is not just the math content. I have to change their mindset and encourage them to always strive to do their best in everything they do. The teaching skills are more important for my job because a large majority of my students failed to learn basic mathematical concepts since they were second graders.

To enhance the student engagement, the CSUB Noyce Program has strengthened its

effort on recruiting first-generation college students who experienced learning difficulties at high-needs schools. One scholar noted that "Coming from a high needs school myself, I am able to connect with many of my students. My drive to motivate them makes a big difference."

Due to the recruitment strategy, Figure 14 shows that most Noyce Scholars are first generation college graduates of their families. Since scholars in teaching were recruited before their peers currently working toward the program completion, Figure 14 also demonstrates an increase of Noyce Scholars from traditionally underserved families.

Figure 14: Distribution of First Generation College Graduates among Noyce Scholars



As new STEM teachers, Noyce Scholars set a role model to guide the progress of their students in high-needs schools. One scholar reported, "My students realize that even though they may be disadvantaged, they can still perform just as good as everyone else." The enhancement of student engagement is reflected in quality of education. The enhancement of teaching skills has resulted in improvement of student learning outcomes. As a scholar concluded,

> I have seen students improve and start to care about their education. I have seen students succeed in what they were challenged with in the past. I have also seen how having

someone who cares in their life is important.

3. Professional Disposition to Sustain School Improvement

Noyce Scholars have exhibited professional dispositions as a STEM teacher at high-needs schools. A scholar derived a strong desire to help students from her own experiences:

> I wanted to become a teacher in a high-need school because I have a personal background I can relate with these types of students. Coming from a Mexican-American family much of my family, I have worked very hard for everything we have earned. I truly believe I can help students in a high-need school.

Disposition gaps have been revealed between Noyce Scholars and the existing teachers at the school site. One scholar reported,

> Most teachers at my school do not care about students. In this low-income school, teachers are unqualified and resort to typical banking education where students are required to take notes and be tested on those notes — this often results in disciplining students and students not learning science through inquiry or hands-on science.

Hence, adding qualified teachers from the Noyce Scholar pool is positive change in high-needs schools. With strong KSD preparation from the CSUB Noyce Program, these new teachers have earned acceptance by their peers. According to a Noyce Scholar,

> My site has shown great respect: the students are respectful and the staff is respectful. This is a good fit! I couldn't imagine myself teaching anywhere else. I have made personal connections with my fellow colleagues and have grown attached to my students. I feel being called to make an impact in this environment.

While Noyce Scholars fulfilled the instructional needs, it should be noted that high-needs schools have been exposed to other issues. For instance, Noyce Scholars repeatedly reported lack of home support for students, which directly hurt student confidence in education. The addition of Noyce Scholars has changed the school culture and enhanced its attraction to counterbalance the home influence. In the end, the impact on student learning has been demonstrated by extensive interview responses from Noyce Scholars like the one below:

> I have taught my school for a couple of months, and my students started to enjoy being at

> school. I think that is because of the general positive culture that has been created. Although some do not necessarily understand the value of education, they like to be a part of the school.

Conclusion

This report includes a thorough examination of evaluation outcomes across nine categories. To support the result summary, Results-Based Accountability has been systematically addressed in three aspects, *Noyce Scholar recruitment (Q1-Q3), STEM teacher preparation (Q4-Q6),* and *service impact in high-needs schools*. Both qualitative and quantitative methods have been adopted to aggregate the multilevel data from electronic surveys, interview responses, and transcript analyses.

To ensure objectivity of this investigation, the external evaluator, JJ Wang, works at a different academic division that has no administrative link to the grant team. It was projected by the original CSUB proposal that "This program will contribute to the knowledge" of teacher recruitment and preparation in STEM fields (Gebauer, 2009, p. 10). To fulfill this commitment, the external evaluator has made a concerted effort on the report dissemination. As a result, past evaluation reports have been reviewed and accepted for publication by the Education Resource Information Center of U.S. Department of Education to enrich the current literature in STEM teacher education (Wang, 2011, 2012, 2013).

At the time of this project conclusion, this summative evaluation shows that the CSUB Noyce Program has already attained the original target of preparing 39 STEM teachers for high-needs schools. The program has demonstrated its effectiveness in enhancing knowledge, skills, and disposition of Noyce Scholars through extensive partnership support. The impact on school improvement is not only indicated by the valuable addition of qualified teachers, but also reflected by student learning outcomes in high-needs schools. Meanwhile, the program save an

approximate $150,000 from the original budget. This report concludes with three recommendations below to sustain the impact of STEM teacher preparation during the period of no cost extension:

1. **Increase accessibility of Noyce Scholars to campus-learning opportunities**

Rationale:

Noyce scholars emphasized the benefit of connection with many professionals during various meetings. More flexibility in the meeting schedule might help expand their access to the rich learning opportunities. The recommendation is supported by the following Noyce Scholar comments:

> *I commuted from Tehachapi. Due to time conflicts, I was not able to attend meetings. It might be beneficial to survey the students in the Noyce program to determine the best meeting day and time. It might also be beneficial to schedule the monthly meetings on a different day each month to accommodate all students.*

2. **Update e-mail addresses to enhance Noyce Scholar tracking**

Rationale:

The Noyce Scholarship Contract stipulates that all scholars must agree to participate in surveys for program evaluation. In this report, Figures 5, 8, and 14 revealed a small portion of missing responses. One of the respondents indicated that she no longer uses her old e-mail address on the office record. Thus, updating e-mail addresses will facilitate future communications to track Noyce Scholar outcomes.

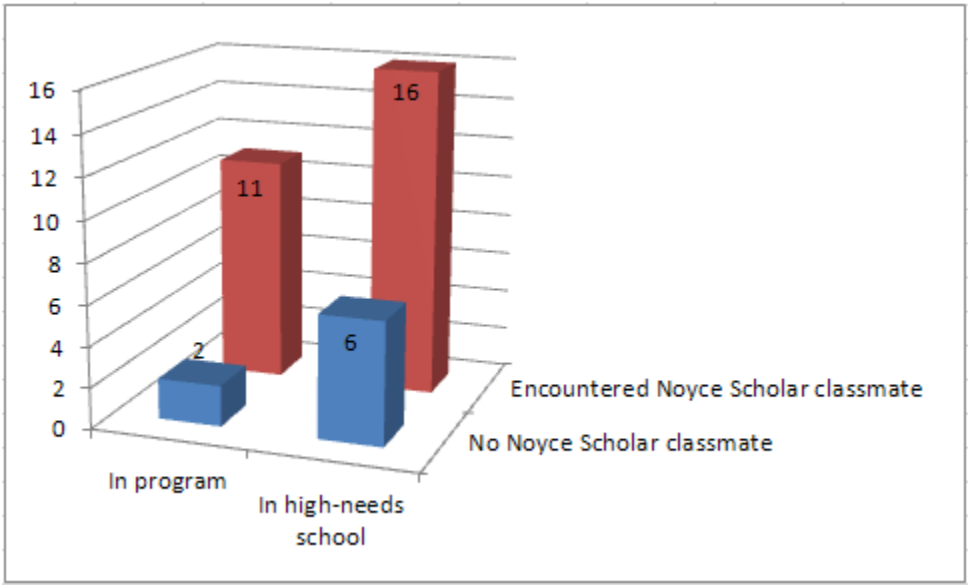
3. **Strengthen the network platform for Noyce Scholars who received one year support.**

Rationale:

Ten Noyce Scholars received the scholarship for one year. Eight scholars indicated having no Noyce Scholar classmates during their program training (Figure 15). Because the network

provides an important support for beginning teachers, this void can be amended by the program coordination to increase partnership collaborations among Noyce Scholars.

Figure 15: Distribution of Classmate Grouping among Noyce Scholars



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Appendix 1: Questionnaire for Noyce Recipients Prior to Program Completion

1. By the time you received the Noyce scholarship, you already (check the one that fits)

__ declared major in mathematics
__ declared major in science
__ switched career/major to mathematics or science
__ entered a credential program with a bachelor degree in mathematics or science

2. What drove your decision to become a teacher in a high-need school? (e.g., finances, rewards associated with teaching, mentors, past experiences, personal interest, etc.)

3. Did you or do you consider other careers that would use your content area training? (if yes, please give the career names)

4. What learning experiences, if any, were extra because you were Noyce scholar?

5. How did you hear about the Noyce program and its scholarship?

6. Indicate the areas in which the Noyce scholar improved your learning experiences at CSUB (check the ones that apply):

__ Stronger connection to Science or Mathematics faculty
__ Better course plan and time management
__ More preparation for working with high-need populations and/or different cultures
__ Better coordinated student teaching experiences
__ More contact with Education faculty
__ Better quality of your overall student experience

7. In comparison to your math or science classmates NOT on the teaching track, you believe that Noyce scholars have

__ stronger academic preparation __ weaker academic preparation

__ similar academic preparation __ difference unknown

8. Please check the following statements that fit your background/past experiences:

__ I am the first generation of college student in my family
__ I know someone working at high-need schools
__ I know math/science teacher(s) without a bachelor degree in the subject
__ The community I live has at least one high-need school nearby
__ I have classmates in the Noyce program
__ I have current information from Noyce local/national conferences
__ I would choose to be a math/science teacher regardless of the scholarship
__ None of the schools I attended were high-need schools
__ If I had to do it all over again, I would take the same program/route into teaching

9. How far would you go with your future education to better address the teaching needs?

__ No further education is needed for the teaching job
__ An MS degree in math/science would help
__ An MA degree in education is desirable
__ A terminal degree (Ph.D. or Ed.D.) in either field

10. From the perspectives of content-knowledge, teaching pedagogy, and/or classroom management, what are the most positive and helpful aspects of your program in general?

11. Please use the space below to provide suggestions for improving your experiences in the Noyce program and/or better preparing you as a teacher in high-need schools (if you need more space, please send an elaborated e-mail to Dr. Wang at jwang@csub.edu).

Appendix 2: Questionnaire for Noyce Recipients Teaching in High Needs Schools

1. What are your reasons for continuing to teach in a high needs school?

2. How long do you foresee teaching in a high needs school?

3. What factors will influence how long you continue teaching in a high needs school?

4. What learning experiences, if any, were extra because you were a Noyce scholar?

5. Your Employment Status is (please choose one)

__ Trying to find a job at a high-need school
__ Currently teaching at a high-need school
__ Finished the Noyce teaching requirement and still teaching
__ Finished the Noyce teaching requirement and no longer teaching

6. How did you hear about the Noyce program and its scholarship?

7. In reflecting on your teaching experiences in a high-need school,

(a) What are the most challenging aspects?

(b) What are the most rewarding aspects?

(c) What are the most helpful aspects of your teacher certification program and/or the Noyce program in preparing you for the challenges of teaching in a high-need school?

8. Please check the following statements that fit your background/past experiences:

__ I am a first generation college student in my family
__ I know someone working at high-need schools
__ I know math/science teacher(s) without a bachelor degree in the subject
__ The community I live in has at least one high-need school nearby
__ I have classmates in the Noyce program
__ I have current information from Noyce local/national conferences
__ I would choose to be a math/science teacher regardless of the scholarship
__ None of the schools I attended were high-need schools
__ If I had to do it all over again, I would take the same program/route into teaching

9. Did you or do you consider other careers that would use your content area training? (if yes, please give the career names)

10. What aspects of the Noyce program support could have been improved? (if you need more space, please send an elaborated e-mail to Dr. Wang at jwang@csub.edu).