

ARISE Project Evaluation

Findings from 2017 Baseline Noyce Grantee Interviews

Submitted to

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Executive Summary

This executive summary¹ presents interview findings from the Advancing Research & Innovation in the STEM Education of Preservice Teachers in High-Need School Districts (ARISE) project evaluation, conducted by researchers from Education Development Center, Inc.'s Center for Children and Technology (EDC|CCT). These interviews were conducted with Noyce grantees about their Noyce programs and their larger STEM teacher preparation programs. The purpose of the interviews was to collect baseline information about 1) how different Noyce grantees organize their Noyce programs, 2) what is similar and different across different Noyce programs, 3) innovative practices in preparing STEM teachers and teacher leaders, 4) impact of the Noyce program on its grantees, 5) the current use of research among Noyce grantees, and 6) possible items for a research agenda. Follow-up interviews will be conducted before the end of the project. An interview guide (included as Appendix A) was developed with input from the ARISE project staff. Interview questions probed for general information about the grantee's STEM teacher preparation program, promising practices, and how the program is using research to inform the development and document the impact of their program. Twenty interviews were conducted via phone between June 1 and September 15, 2017. The interviews were coded thematically using the Dedoose platform. The interviewees had the following characteristics:

- **Role.** 19 Principal investigators; 1 co-PI (the co-PI connected with the researchers at a Regional Summit)
- **Content area.** 17 included a science focus; 15 included a math focus; 3 included a technology focus (15 programs were interdisciplinary)
- **Geographic area.** 2 interviewees each from California, New Jersey, and Illinois. 1 interviewee from each of the following: Alaska, Arkansas, Georgia, Hawaii, Minnesota, Missouri, Nebraska, New Hampshire, New York, Oklahoma, Pennsylvania, Rhode Island, South Dakota, and Texas
- **Type of university.** 18 public universities; 2 private universities
- **Project start dates.** Ranged from 9/1/2010 to 2/1/2016
- **Prior Noyce grants?** 8 yes, 12 no

The findings from these interviews are summarized below in three main areas of STEM teacher preparation: Promising Practices, Contextual Challenges, and Grantee Use of Research. The full report includes full findings organized by theme, with illustrative quotes. The themes were generated during the coding process. Although we report the number of participants who mentioned each theme, the inferences that can be drawn from these numbers are limited, given the small sample sizes and the fact that the interviewees were answering open-ended questions.

¹ This material is based upon work supported by the National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Findings about Promising Practices

For the purposes of this report, “promising practices” refers either to teacher preparation strategies that interviewees specifically identified as contributing to the success of their program, or other strategies that the interviewees described that seem novel or innovative. Since there was often a blurring of lines between supports provided only to Noyce scholars and supports provided to the larger pool of STEM teacher candidates, this analysis included strategies aimed at both groups. All 20 interviewees discussed some type of promising practices in preparing STEM teachers, although the specific areas that they covered in their interviews varied. Interviewees mentioned promising practices in relation to the following aspects of their program: recruiting, collaboration, fieldwork/induction, teaching diverse learners, technology, instructional strategies, retention, and certification.

Findings about Contextual Challenges

Nineteen out of 20 interviewees mentioned some type of contextual challenge that they encountered in implementing their Noyce and STEM teacher preparation programs, with the most common challenge being recruitment issues, and other challenges including state and district policies, teacher and Noyce scholar retention issues, the university context, working with diverse populations of K-12 students, and induction issues.

Findings About Grantee Use of Research

Research was discussed in some capacity in all 20 interviews. The research-related themes that arose in the interviews included the evidence base for their STEM teacher preparation programs, types of data collected, research challenges, research questions posed by the interviewees’ research, research questions they would like to see addressed in the field, suggestions for AAAS supports for research, and dissemination.

Thirteen interviewees made suggestions for additional supports for research they would like to see from AAAS, covering a range of topics such as more small meetings or working groups among Noyce recipients, support for dissemination through conferences and advice about where to publish their findings, encouraging more qualitative research, helping to elevate STEM teaching as a profession, and adding more resources to their website. Interviewees appreciated the opportunity to meet with district representatives in the regional meetings. They felt that small meetings could be more focused and engaging, and could help continue the momentum and connections that were created in the annual meeting. The meetings could include working groups around topics like research and science teacher education. Additional resources on the Noyce website could include sample contracts, syllabi, instruments, and research findings.

Introduction

This report presents interview findings from the Advancing Research and Innovation in the STEM Education of Preservice Teachers in High-Need School Districts (ARISE) project evaluation, conducted by researchers from Education Development Center, Inc.'s Center for Children and Technology (EDC|CCT). The ARISE project is led by the American Association for the Advancement of Science (AAAS), with funding from the National Science Foundation (Grant No. DUE-1138038). The ARISE program intends to provide resources and build a network to foster research and evidence-based innovation in STEM preservice teacher education and leadership development programs, including research on (a) effective STEM teaching, (b) preparing STEM teachers for the future, and (c) the most effective ways to recruit, train, and retain a high-quality STEM teacher workforce. This network will share and exchange ideas about topics and strategies for research and about evidence-based approaches for attracting, preparing, supporting, and retaining STEM teachers in high-need school districts.

The interviews summarized in this report were conducted with Noyce grantees about their Noyce programs and their larger STEM teacher preparation programs. The interviews were conducted and analyzed by researchers from EDC|CCT. The purpose of the interviews was to collect baseline information about (1) how different Noyce grantees organize their Noyce programs; (2) similarities and differences across different Noyce programs; (3) innovative practices in preparing STEM teachers and teacher leaders; (4) impact of the Noyce program on its grantees; (5) the current use of research among Noyce grantees; and (6) possible items for a research agenda. An interview guide was developed with input from the ARISE project staff. Interview questions probed for general information about the grantee's STEM teacher preparation program, promising practices, and how the program is using research to inform the development and document the impact of their program. A copy of the interview guide is included in Appendix A.

Twenty interviews were conducted via phone between June 1 and September 15, 2017. Eighteen interviews were recorded and transcribed; the other two interviewees did not consent to be recorded, so detailed notes from the conversations were used for analysis purposes instead. The interviews were coded thematically using the Dedoose platform. The interviewees had the following characteristics.

- **Role.** 19 Principal investigators; 1 co-PI (The co-PI connected with the researchers at a Regional Summit.)
- **Content area.** 17 included a science focus; 15 included a math focus; 3 included a technology focus (15 programs were interdisciplinary)
- **Geographic area.** 2 interviewees each from California, New Jersey, and Illinois. 1 interviewee from each of the following: Alaska, Arkansas, Georgia, Hawaii, Minnesota, Missouri, Nebraska, New Hampshire, New York, Oklahoma, Pennsylvania, Rhode Island, South Dakota, and Texas
- **Type of university.** 18 public universities; 2 private universities

- **Project start dates.** Ranged from 9/1/2010 to 2/1/2016
- **Prior Noyce grants?** 8 yes, 12 no

The findings from these interviews, along with illustrative quotes, are summarized below in three main areas of STEM teacher preparation: Promising Practices, Contextual Challenges, and Grantee Use of Research. Within each area, the findings are organized by theme. The themes were generated during the coding process. Some themes, like recruiting strategies, arose in response to specific questions about that topic, while other themes, such as retention, came up repeatedly in response to more general questions. The themes in each area are presented in the order of how often they were mentioned by participants. This report also includes a summary of interview findings and recommendations about the Noyce Annual Summit, as covered in greater detail in the Memo Regarding Summit Recommendations (attached as Appendix B).

Please note that, although we report the number of participants who mentioned each theme, the inferences that can be drawn from these numbers are limited, since the interviewees were volunteering information in response to open-ended questions. While a certain number of participants may have brought up a given theme in an open-ended prompt, other participants might have answered the same way if they were asked about the topic more directly. For example, although 10 interviewees mentioned promising practices around retention in response to a general open-ended prompt about promising practices for supporting STEM teachers, other interviewees might have mentioned promising practices around retention if asked for this information directly.

Findings About Promising Practices

For the purposes of this analysis, “promising practices” refers either to teacher preparation strategies that interviewees specifically identified as contributing to the success of their program, or to other strategies that the interviewees described that seem novel or innovative. Since there was often a blurring of lines between supports provided only to Noyce scholars and supports provided to the larger pool of STEM teacher candidates, this analysis includes strategies aimed at both groups. All 20 interviewees discussed some type of promising practices in preparing STEM teachers, although the specific areas that they covered in their interviews varied. Interviewees mentioned promising practices in relation to the following aspects of their program: recruiting; collaboration; fieldwork/induction; teaching diverse learners; technology; instructional strategies; retention; and certification. Below we summarize their responses in order of the most frequently mentioned program components.

Recruiting

All 20 interviewees discussed their recruiting strategies. A number of strategies were popular across half or more of the interviewees. These included getting referrals from faculty advisors, sometimes with work needed in advance to get faculty buy-in; using scholarships to recruit

teachers from high-need populations, such as students from racial and ethnic minorities and low-income backgrounds; implementing internship programs that let students try teaching before enrolling in the Noyce program, such as working in a summer camp or other informal learning opportunity; and targeting career changers.

Getting broad STEM faculty buy-in to advise students to go into teaching was sometimes difficult for Noyce grant leadership, according to the interviewees, but could pay large dividends, as illustrated in the quotes below.

*We have worked with many faculty and many department chairs and many administrators, for that matter, to recruit students into our program, to raise the profile of the program. **We run workshops for the faculty on campus to go through and learn about our program. So they can become our emissaries or ambassadors—go through and help students learn about it.** ... I know many programs have had great struggles in getting warm bodies. We have nearly twice as many applicants for every scholarship that we have awarded. So we have genuine competition for these scholarships on our campus. And I directly attribute that to personal relationships with all these faculty—students they are advising through classroom interaction.—Participant 1A*

*We had a pervasive attitude down in our Math Department that was, you don't want to go into teaching math. You're too good for that. You should go to graduate school. That kind of attitude needed to change. That teaching is still a very honorable profession. So we had to overcome that, and I think that we have. ... So we're a small enough school that, really it's the personal touch that gets students to be thinking about going into teaching rather than something else. And that teaching is not the catch-all afterwards. "Well, if I can't do this, then I'll teach." That it should be a first choice. ... **We had one person, one math professor, a young one, who was vocal and kept on promoting education, you know, teaching was a good profession. But the second thing was the Learning Assistants [students who help to facilitate activities in the classroom, and who conduct help sessions for fellow students]... I mean, they saw what these students were doing and they were participating in the programming. They were getting money from this grant. I think that it just sort of softened their thoughts.—Participant 1B***

Participants were also very enthusiastic about their internship programs, both as a recruiting tool and as a form of early fieldwork for future Noyce scholars, as explained in the following quote.

*We were forced to start recruiting very early, because that's the [program] model, but what has been successful for us is **reaching them as soon as they're on campus and offering them an opportunity to try out teaching with few strings attached and low stakes.** ... **We do it as a one credit-hour course, which for a fulltime student doesn't add any cost to their semester.** In that one credit-hour experience, they get to go out into the field and make two observations of a mentor teacher and then, in pairs, teach three lessons over the course of the semester. ... We start them off with an experience*

with elementary students so they're not going back and working with people who were their peers four months ago. That would be a little uncomfortable. But also we want them to get ... the rock-star treatment, and they'll get that because they're not their teacher and they're young. ... And if somebody decides after that experience that teaching isn't for them, we know that teaching probably really isn't for them, and we wish them well and send them on their way. If they think it's something they could be interested in, or if they've already fallen in love, then we have another one credit-hour experience where they take a step up to middle school. ... We know that they're probably going to be somebody that sticks with us through ... their requirements if they end up wanting to become a teacher, but since it's only one credit-hour for those experiences, we pitch it very widely.—Participant 1C

One form of recruiting mentioned by fewer than half of participants was hosting recruiting events or recruiting at other events such as career fairs and panels, information sessions, activities fairs, open houses, freshman orientation, and a campus-wide Exploring Math night. Some interviewees worked with other university offices and programs—such as the Student Center, Office of Support and Partnerships, Office of the Dean, Upward Bound, Educational Talent Search, UTeach—sometimes piggybacking on recruiting efforts by other programs. Another strategy was presenting at seminars specifically geared towards careers in STEM, and educating college students about teacher shortages so they understand their potential job prospects. Other promising practices mentioned by fewer than half of the interviewees included recruiting early, such as among high school students; encouraging students to try out education courses early in their college career; and recruiting via classes, student groups, university websites and email lists, word of mouth and through other Noyce scholars, letters to entering freshmen or past alumnae, and accelerated degree programs. Finally, some interviewees had success partnering with community colleges for recruitment purposes, although, as explained in the Findings About Contextual Challenges section (below), this strategy did not work out well for all of the grantees who tried it.

Collaboration

Virtually every interviewee (19 out of 20) discussed the importance of collaboration in the success of their programs, with the large majority of these comments relating to school and district partnerships (also mentioned by 19 out of 20 interviewees). According to interviewees, strong school and district partnerships were vital in finding fieldwork sites for their Noyce scholars that were both in high-need schools and had high-quality teacher mentors, as explained further below. Sometimes the district partnerships were formal and part of the grant, and sometimes they were more informal and ad hoc. Interviewees mentioned that universities can make their course offerings more relevant to future teachers, and make their graduates more attractive to school districts, by getting district input on coursework and professional development for preservice and in-service teachers, and sometimes even having master teachers co-teach, to make sure that they are relevant to future teachers. Close district partnerships also can be mutually beneficial for recruitment purposes. For example, faculty can visit schools to encourage high school students to go into STEM teaching, district teachers can visit prospective or current Noyce scholars to give them information about what it is like to be a

teacher in a high-need school, and principals can attend university workshops to recruit teachers for district schools when they finish their preservice program. District partnerships also can help with placement, such as clustering multiple student teachers in the same site, having remote rural districts provide housing for student teachers, and placing interns in district-sponsored summer camps and other educational programs. The following quotes provide examples of how Noyce programs partnered with school districts.

Since 2004, we've created over 25 courses for teachers, and we work really closely in that these courses tend to not just be created in the abstract by mathematicians, but instead we partner with specific teachers to help co-create a class, and then our summer model, of course, is we do a lot of intense but short courses. ... If we have a group of 30 teachers doing this, we might have five instructors in the course and those five instructors would probably be something like one faculty member, one graduate student and three master teachers. And so districts appreciate knowing that if they are encouraging their teachers to take a class from [us], it's not going to just be a lecture, but that it involves actual teachers. Maybe even teachers from their district in the instruction, and that these courses were designed for teachers.—Participant 1D

*I think the other thing that is really beautiful, and this occurs during the workshop, to me, it's the way education should be. **You have higher ed faculty. You have practitioners in the field. And then you have preservice students all together for a week and talking about their practices, talking about their successes and talking about their challenges.** That really resonates well with me, and I think that's a real positive outcome. ... One of the things in our assessment is that they really enjoyed talking to teachers in areas, in other schools, that are considered high-need or under-performing schools and talking with them. It's affirming. So, for example, every year for this workshop, they're repeaters. They keep coming back. It's not required that they come back, but it's the same. There's a variation of, like, maybe two or three different people but, for example, there's one woman, a biology teacher—this is the third year that she's attended, and at the beginning of the workshop, she said, "This was such a frustrating year for me," and she just felt like she was really down at the bottom of the barrel. And I think that the opportunity to not only work with other people in neighboring school districts, but to have the chance to kind of talk about what the difficulties she had, was good for her. She's a great teacher and I think these teachers sometimes just get really down because they have a lot of things that are really challenging for them in their jobs as an educator.*

—Participant 1E

*With Phase II, **we had a number of partnerships with existing school districts.** So a lot of the school districts know that we have a strong reputation for building good solid teachers, and they want these students to come apply and work at these schools. So then you have lots of principals who attend our workshops and try and do a little job headhunting.—Participant 1A*

Interviewees suggested a number of promising strategies for strong collaborations between districts and Noyce programs, including working with districts on grants, investing time and communication into the collaboration, having relationships with key district staff (such as science coordinators), hiring former school district staff, disseminating positive teacher and student outcomes from teacher preparation programs back to the school districts, making the collaboration two-sided and mutually beneficial, and inviting district staff to regional Noyce meetings. The following quotes illustrate some of these collaboration strategies.

A lot of the partnerships initially started from when we had grant funding, we were recruiting teachers, but we work really closely, especially with the math supervisors in the biggest districts, and when we've had different grants, we have them be on the advisory board or we actually involve them as a co-PI, depending on the project.

—Participant 1D

*We have a very talented staff member who has a journalism master's degree, and so we have **her create these publications for us that report back to districts on the success of some of these programs in terms of teacher learning and student learning.** And so we share that with districts and encourage them to share that with their school boards to have them say, "Look, we know we have a problem in mathematics, but we know that if our teachers go through this math program, then they learn more, their students learn more. So if we put up this much money per teacher, then we can have more teachers do this; and if our district puts up the money, then the university will hire master teachers from our district to help teach the courses. The courses will be offered in our district so people don't have to drive to [the university]." I should have mentioned also, **a lot of our summer classes we don't offer [at the university]. We offer them in the local communities where our partners are.** So that helps make it attractive.—Participant 1D*

*I think it's just having time and the space to talk about things. And going into it, it's got to be win-win. I think **both partners have to learn from each other and teach each other, because we all have our varied expertise.** That's why I love that regional meeting, to have [the district] at the same table as us for an extended period of time; that never happens. ... I think it's all about relationship building, and it's win-win, because the districts need our teachers. We need to best prepare our teachers, and the districts, they're there all the time. I go visit them once every other week, so I think really having a strong collaboration is going to be best for everyone.—Participant 1F*

*Be really patient and persistent. I mean, one challenge is that the school district staff turnover is really fast, and so you have to keep up your connections with the school district and keep going back and having the same conversations again and again, because there are a lot of people who are new; and then to realize that the school district people work at a pace that is often just crazy, and they are rushing all the time, and so expecting them to take a lot of time to sit and mull things over and discuss things and read your documents is not reasonable. So I guess **my advice for working with school districts, and really working with partners in general, is to accept with gratitude***

whatever they have to share and then be persistent. But I do feel really happy that the Noyce project has given us an opportunity for extended relationships with districts that they might not see much benefit in otherwise, but I think at this point, they feel like we're their long-term partners, which is really great; and having two Noyce grants, one after another, has really supported that because, at this point, they've actually got a lot of our grads in their classrooms.—Participant 1G

What really brought us all together on the same page is, we all—the leaders from each of the three organizations—we all went to the Midwest Regional Summit, I guess it was last year, in 2016, and it was awesome for me to no longer have to be the go-between in between all these people, or trying to introduce people over email, or trying to get everyone in the same room. It was just great for us—it was like a retreat for our team to be able to go to the Noyce summit and they also, you know, being from a school district and being from a community college, they're not familiar with the Noyce program at all. So for them to be able to see that this isn't just some great, crazy thing that [I] dreamed up, this is like a thing that happens at a lot of institutions, and there's a lot of potential there to make it a long-lasting partnership. So I think it's not really a strategy, but that was a big turning point, I think, for the team of people that are always working together to pull everything off.—Participant 1H

Other collaborations mentioned by interviewees, besides school districts, included partnerships with informal learning institutions, such as arboretums and museums, primarily for internships; collaborations with outside groups such as 100Kin10; collaborations with community colleges, mostly for recruiting purposes as mentioned above; and collaborations within the university, either between the education departments and science/math departments as part of the Noyce grant, or with other university programs such as Upward Bound and UTeach.

Fieldwork/Induction

Strategies for promoting successful fieldwork and induction experiences for their Noyce scholars was an important theme in the interviews, mentioned by virtually all of the interviewees (19 out of 20). Specific strategies for fieldwork included early field experiences, such as having prospective Noyce scholars teach in summer camp internships, or having them tutor other undergrads. These types of experiences can serve both as recruitment tools, as noted above, and to make sure that Noyce scholars have as much fieldwork as possible, which was seen as important in preparing high-quality teachers. Some participants also mentioned intensive fieldwork requirements for teacher candidates after they became Noyce scholars. Another strategy for successful fieldwork was clustering interns at fieldwork sites, as noted previously. The following quotes illustrate the strategies for fieldwork noted above.

We started offering internships at the Zoo ... the Arboretum ... And these internships were freshmen/sophomores, as dictated by the grant, and they were early field experience, and I can say that I am just so impressed by the growth of the students as well as the internship sites actually offered. I mean, they did a fantastic job in offering a worthwhile product that had to do with education. Some of the students were camp

counselors, kind of, but they were asked to develop the activities and make sure that they had some sort of connection to the NGSS, which they did. ... And they did the CIG training. CIG means Certified Interpretative Guide training ... and it's just a really fantastic way of getting students to think about how to put together a presentation, how to give the presentation, asking questions, what kinds of questions are going to be effective, what kinds are not, how to tie things together, make sure that they walk away with some tangible information. ... And the reflections that we have, I mean it just really shows that they really learned a lot, and we did get some to go into teaching that way.
—Participant 1B

*Typical, for us, would be some kind of ten-practicum in the fall and then fulltime student teaching in the spring. Instead, **we had the teaching fellows participate in their field experience for the entire school year.** So they started before school started, going to, like, the work days before school started, and they were there from then until the last work date after the end of school. So they saw an entire school year, including those crucial first few weeks when the collaborating teacher was kind of setting the classroom culture. We thought that would be very important for helping to prepare students to teach in equitable ways.*—Participant 1D

*We were deeply involved in the selection of the cooperating teachers. Typically, that doesn't happen, that function is normally taken up by the Center of Pedagogy, but the second year, and then looking ahead to next year, with Cohort Three entering students, you know, their field work here next year, **we were able to hand pick cooperating teachers.** ... So the innovation that we're trying to spread now to the rest of the department—and this is something that's a lesson learned from the residency programs, frankly—is to **make sure that our teachers are placed in pairs at schools.** So we worked with two partner districts, both urban districts this past year ... It allowed us to work with individuals in those schools and have a little bit more focus, and allow those Noyce scholars to support one another. One of the things we've seen in teacher ed is when you have somebody just sort of placed by themselves out of their school, which may be out of necessity. Maybe you can only find one cooperating teacher out there, but it can lead to feelings of isolation, and they can drift away from the goals of the program. So we felt it important to place them in pairs, and to have some control over that.*—Participant 1I

Some interviewees mentioned intensive induction and mentoring programs. However, other programs left most of the induction and mentoring activities to the district, either because the district induction programs were already intensive, or because the university did not have resources to provide intensive induction support. Those programs provided less intensive supports, such as giving teachers money for materials, for attending conferences, and for substitute teachers for inter-visitation and professional development during their induction period. A number of interviewees explained that, because teachers have a lot of demands on their time from school districts, they did not want to burden new teachers with a lot of university requirements, so they offered teachers these types of resources instead. Please see also the Technology section, below, for a description of online platforms for supporting Noyce

scholars and alumnae during fieldwork and induction. The following quotes illustrate one more intensive induction program and one less intensive induction program.

*We have what I call a **scholar leader**, and that person is a retired math and science teacher; it turns out, she's taught both for many years. She goes to visit every single Noyce graduate at their school and provides support to them in their classroom and observes, visits with their **mentor teacher**, which is another thing we have. We also pay mentor teachers when they [the Noyce scholars] graduate. They select, or they are assigned, a mentor teacher who helps them through their first two years—two to four years of teaching, and they also pay a stipend. So once they're out there for induction, the scholar leader, the mentor teacher that's in the school, hopefully next door to our teacher or close to our new teacher scholar, they provide support and go visit, and then we get the principal involved as well, and provide as much support as we can. We also have **pedagogy mentors**, and I already mentioned the **content mentors**, and they are also paid a stipend to maintain contact with the Noyce scholars while they're at [the university] and after, when they graduate, on issues or questions or concerns about teaching. **So there's several faculty in science and math education that are from the College of Education that are paid a small stipend, but just to maintain contact with our scholars for support in teaching**, like classroom management or whatever it happens to be, and then the content mentors are mostly the PI and co-PI team, which are biology, chemistry, and so on.—Participant 1C*

*What we've ended up doing is to **have a very open-ended early career support for our grads**, where we put aside money for each of them for classroom equipment, to attend professional development meetings, and to pay for subs so that people can be—either can observe other teachers or be observed by other teachers, which are things that aren't necessarily well-funded in the school districts where they're going to work.—Participant 1G*

Teaching Diverse Learners

Given the Noyce program's focus on high-need schools, it is not surprising that a large majority of interviewees (17 out of 20) discussed the importance of preparing their Noyce scholars to teach diverse learners. One common strategy for preparing Noyce scholars to teach diverse learners was being intentional about where they placed their student teachers. A number of interviewees discussed that having their scholars work with high-need students really changed the scholars' attitudes toward these groups, particularly when paired with strong teacher mentors and other supports. This was seen as especially important when the population of teacher candidates was different from the population of students they would be serving. The other main strategy for preparing Noyce scholars to teach diverse learners was to teach them about culturally responsive and relevant pedagogy. This took various forms, including special courses dedicated to the topic, integration of the topic throughout the preservice coursework, and integration of the topic into special workshops for Noyce scholars, sometimes with expert guest speakers. The following quotes provide examples of how interviewees prepared their Noyce scholars to teach diverse learners.

We also need **community mentors. They actually explain to our students the culture, how to engage indigenous students in place-relevant learning.** ... We select a topic and train our students on how can a village deal with using electricity, how to solve the high electricity costs, or how to work on clean water, clean drinking water issues. ... Those are topics people are really interested in. ... They're predominantly White teachers, who sure need some help even understanding what is going on out there and how to make that teaching relevant. Let's put it this way: What it means is establishing excellent student-teacher relationships, being respectful of their culture. It does not necessarily mean teaching the culture in the school. That's not what the native people want to see, that a White man teaches that culture. And native students have a different measurement of success, and also how to get engaged. So it's very clear they react very well to hands-on instruction, they watch how things are done. So that different teaching methodology is they work better to engage a native student compared to what you do in a mainstream school.—Participant 1J

Just being in the schools and learning to be comfortable in any environment, because they're with a teacher who's teaching in that high-need school, a very diverse, economically disadvantaged school, and that teacher is guiding them through the process and showing them how to be successful, along with our own faculty. So they have that support on how to be successful in those environments and how to address learning for all students. ... The first course that they take that's kind of for real is what we call knowing and learning. Then they start understanding why the learning cycle is structured the way it is and why it is such a great tool to use in the diverse environment. You can't just talk about a roller coaster in a physics class and everybody's been on one. You've got to give everybody an experience right then and there so they can share and draw upon that to further the lesson—yeah, airplanes or anything. So the learning cycle is just the ideal delivery method for dealing with a diverse population.—Participant 1C

So by **bringing the local culture in—it's one of the things that's really important here, no matter what you teach, because that's how you're going to get that face validity with your students.** ... So I tell students to get engaged, and you learn about the culture and there's so much out there, so many resources to actually help them learn about it, and then when you can bring it in, then it really helps you connect with the kids, because a lot of our students ... they're not going to necessarily ask you questions if they don't feel comfortable, but they will be very respectful to the teacher. But if they're not understanding it, they're just going to shake their head and say, "Okay." So you have to use that—the culture—to really get them to open up to you, and we even have it here at the college level. All of my students have to come in to at least one of my office hours just to sit and "talk story," because without that, they won't open up, and they'll just sit there, "Okay, yes. Yes, ma'am. ..." That's what they say out here, you want your students to sit and talk story. So they're able to talk to you and open up with you about stuff, and it could just be little things, but here, that aspect of taking the time to sit and talk story is crucial. ... That time to go to the important events. Here, it might be some of the cultural

events that are happening all around, to show that you're supportive of them. ... We have different organizations that, at the state level and at our local school levels, that will help with mentoring teachers if they're interested, to show them that culture.

—Participant 1K

When I put the grant together, I said that we would **develop a course called “Teaching in Areas of High Need.”** It’s a two-credit course. It has been intensely popular and it’s a wonderful, wonderful thing. Our courses are four credits. So this is a two-credit course, which means it would be half of a semester, seven and a half weeks. And it’s really good, and the feedback that the students gave is that they really like the class but they would like to have more practicum incorporated into it. So this last year, the third year, that’s exactly what we did. Instead of it just being a seven-week course, so there’s seven weeks of classroom instruction, and then the other seven weeks of the semester, the students are out in areas of high-need schools doing practicums and observations.

—Participant 1E

[In the workshops] we do different kinds of activities. One example is we had a morning activity where we had everyone do a **poverty simulation**. And so they’re doing a role-playing activity where they are trying to survive in different kinds of family groups using Monopoly money to go through and cover day-to-day life. And so it’s an immersion activity to give students a sense of, if you’re living at or below the poverty level, what your day-to-day life might be. And when you’re asking students to buy supplies for your classroom, or why doesn’t the parent come in for a teacher-parent conference, I teach a little bit of empathy and understanding. People have these very challenging lives beyond their children in the classroom.—Participant 1A

The summer between their junior and senior years, after they’ve done the research internship, they do another online course and I just call it the **Noyce seminar**. Basically, we read a lot of articles on underrepresentation and why it happens, and opportunity gaps, and teacher expectations, and implicit bias, and basically all of these causal factors behind why we have underrepresentation, and we discuss in the class how these things begin with what happens between teacher and student and the classroom. There are some really telling assignments in this class. At one point, I have them identify where they are on their—all of them this year that had to take this were White, so I had them identify where they were on the spectrum of White identity development—like White racial identity development. And that reflection assignment was really challenging for them, but also really almost cathartic. I feel like this class in particular kind of addresses what is missing for a lot of teacher education programs. I think teacher education programs do, generally speaking, talk about the values behind a democratic education, but I think most teacher education programs, probably ours included, is too afraid to force preservice teachers to reflect on their own racial biases, and root them out, and talk about how they can come up—they can come out in their teaching actions. So I don’t know, I would say that—this is the first year I’ve had to teach that seminar, because it’s the first year that we’ve had a cohort reach this point in the program, but I

would have to say, as an instructor, it's my most rewarding component of the program, because I saw such movement. In an online class, I never expected that. ... I'm happy to share syllabi and our reading list and everything.—Participant 1H

*[In the workshops], we had them read some articles, talk to teachers. I think once a year at least, we had **a panel of teachers from different school districts across the state**, so one group came from the north country. We had teachers that came from the urban areas. We had teachers who came from that school district just over the border, that we had an internship site at. We had teachers who came from—one year we had a variety of different schools. So one was a teacher from an urban school, a teacher from a rural school. We had teachers who sent their kids to the Upward Bound program, a teacher who was homeless herself at one point in her life.—Participant 1L*

Technology

Twelve interviewees mentioned using technology in innovative ways to help prepare their Noyce scholars. Most of those responses included some type of online platform or course to be used during internships, fieldwork, and/or induction periods to promote a community of practice and ongoing support for current and former Noyce scholars, such as eMentoring for Student Success. This is an especially useful model for rural programs and other programs where teachers are spread out. Components may be synchronous or asynchronous, and may include teachers planning and sharing lessons and videos of their practice in groups, sometimes with faculty feedback; online meetings around issues of practice, such as culturally responsive teaching, classroom management, or inquiry-based learning; and interactive online professional development courses for new teachers. The online platforms sometimes include Noyce scholar's teacher mentors, and summer interns who are not yet enrolled in the Noyce program. The following quote describes an example of such a platform.

We do a monthly meeting online where I get my alumni Noyce scholars, as well as my current Noyce scholars, as well as potential recruits in a monthly meeting talking about issues around science teaching. *Whether it's assessment, or management, or inquiry, it's whatever the scholars need. There's a segment where we introduce a topic and then there's a good chunk of the time where it's scholar-centered. So they choose what the topics are and then we facilitate the discussion to whatever problem of practice, or we call them Trojan victories, too. They can share what's working in their context. So I have students from New Jersey to Washington State to Southern California, so across these areas they all meet online and I think they really appreciate meeting online. ... When we do synchronous online with Adobe Connect so they can all see each other, I think commiserate and also problem-solve and just be support for each other, I think that's huge. The one other thing that I've talked about in many different places, from the ASTE conference to also the Noyce conferences in DC, it's our **online learning community** where they share video of their practice and they problem-solve around video. Not just conversations during our monthly meetings, but also there's a synchronous space where they can share videos, share feedback, ask questions, give each other praise, really around their practice. That, I think, is the key within our*

program. It probably comes from my background in athletics, but watching yourself compete, watching yourself teach, watching yourself interact with the students, and learning from that ... I think the candidates go through the video first and kind of reflect on that and share—kind of annotate what’s going on and their own reflection, and then the feedback from their peers and also the [faculty] mentors ... are also in this community. I think that is one of the kind of cornerstones of our project.—Participant 1F

Other examples of uses of technology to prepare their Noyce scholars included using an online tutoring platform to give prospective Noyce scholars an early fieldwork experience; platforms that are already in common usage, such as Facebook, Adobe Connect, Skype, and Google Hangouts, to connect with current and past Noyce scholars; and platforms such as Desire to Learn to share information about STEM careers, including teaching.

Interviewees also discussed how they prepare their teachers to integrate technology into their teaching, such as having teachers learn about implementing technology by attending conferences on the topic; pairing them with mentor teachers who are strong in this area, as identified by district partners; providing special workshops for Noyce scholars on technology integration in STEM classrooms; and providing classes on the topic. The following quote describes one such course.

*One of the things we had were students who were struggling with using the technology, and we were, like, “Well, wait a minute, they have a **technology class** before they come in,” but it turned out that that class was focusing more on ... not things that teachers needed to use the technology for—like using the iPads. Out here, a lot of the schools are using the iPads, even in first grade, and the SMART Boards. Our students weren’t knowing how to use them, and the teachers had them in the classroom but weren’t proficient in them, so we switched the curriculum in that class to really focus on, “Okay, so what’s actually happening in the classroom? And now let’s switch that class to focus on how do we use iPads in the classroom? How do we use SMART Boards in the classroom, and make our students proficient in Excel and Word?” ... It just wasn’t originally giving them the technology they needed. And then, most recently, we’ve revamped it a little bit more, because a lot of our schools are now using Google Classroom. So we want our students to go in there knowing that. And it’s worked well, because now we’ve had our students go, “Oh, now that I know how to use this, my collaborating teacher is having me show her how to use it, or him how to use it,” so they’re getting to give it back.—Participant 1K*

Instructional Strategies

Twelve interviewees mentioned specific instructional strategies that they wanted to promote among their Noyce scholars. These strategies generally consisted of student-centered, active learning approaches such as inquiry-based learning, integrated science instruction across the disciplines (life and physical sciences), less lecturing, differentiated instruction, project- or problem-based learning, and Next Generation Science Standards (NGSS) practices such as argumentation. Several participants also mentioned that they have their teachers conduct

inquiry, whether it is studying children closely, inquiring into their own teaching practices, or conducting scientific research of their own. The following quote describes one example of how programs are promoting inquiry-based teaching strategies among their Noyce scholars.

*During their junior year, they do a **research internship**, and I feel very strongly, because of NGSS being so focused on inquiry practices and then science and engineering practices, which are essentially inquiry practices—I feel very strongly that **teachers need an opportunity to really practice as scientists before they teach**. I think it's asking too much of anyone to expect people to be able to teach inquiry without actually engaging in it themselves. The reality is that most of the teachers that we're training, they did not do inquiry in their science classrooms when they were going through school, but yet we expect them to teach entirely differently than how they were ever taught, and having never practiced as scientists. I think that's crazy.—Participant 1H*

Only a few interviewees mentioned specific teaching strategies that their faculty used to prepare Noyce scholars, such as having their students watch and discuss videos of teacher practices, or using active learning strategies in their classes. This is not entirely surprising, given that professors are generally given little training on how to teach their courses. About half of interviewees discussed other ways that they prepared their Noyce scholars, including innovative STEM courses, such as discipline-specific pedagogy courses; using Noyce scholars as Learning Assistants to help teach STEM and education courses; conducting enrichment seminars and workshops for their Noyce scholars, sometimes with expert or teacher guests covering a wide array of STEM teaching topics; having their scholars attend internal and external conferences as professional development, or actually present at such conferences to boost their confidence and speaking skills. The following quotes include examples of some of these innovative strategies that interviewees used to prepare their STEM scholars.

*I actually look for alumnae to give presentations, and they usually volunteer and, because it's kind of a low-risk atmosphere for them, they can present and they're comfortable with everyone and it's a nice environment. It's **a smaller conference** and so it's less intimidating. So it gives them opportunities to practice doing presentations and talk about innovative things they do in their teaching. We always bring in an outside speaker that's usually a nationally known speaker. So we do that, and that person will usually give a keynote the first night of the conference, and sometimes they also do some sort of workshop with everybody, too. And we also invite a few area teachers who are in the area and who are interested, and invite them to come join us and take advantage of the program, and some of them are going to know some of the scholars anyway.—Participant 1M*

*Our LA program, **Learning Assistant program**, to me this was very, very transformative in the College of Science. And so we have these LAs, these Learning Assistants, who not only work in the classroom, so they're facilitating activities in the classroom, but some of them will be running help sessions during the week. But these help sessions, they're not just a “stop in, do students have any questions” kind of thing; they actually have*

prepared things to do, and they work with their faculty mentors on all this. But I really found that the University of Colorado model—what they require is, they require a weekly pedagogy seminar and this is where the students really learn what it means to teach and what it means to learn. They become little professors. “Well, they just didn't get it when I said it this way. How am I going to help them get to that point, you know, where they learn?” And they have a lot of really great discussion. We do have them read papers and the literature, and how it applies to what they're doing. It's just, again, a very transformative thing, for not only the students but also for our professors.

—Participant 1B

*I think our **workshop series** was appreciated by the Noyce scholars, and if we had a Noyce scholar who was in the program for three years—so their junior year, senior year, as well as completing the master's program, you know—we tried to keep it fresh and different every year for them. You know, just having that sense of community with the other Noyce scholars. I have some who, they're still keeping in touch with their co-Noyce scholars, their peers that went through the program. We fed them, we hung out together, and had some good conversations. It wasn't anything intentional, but just kind of a way ... to foster community, and they all were going through the same thing at the same time. ... They were in some of the same courses together, or they might have been in the same internship site together. ... We all participated in the workshops. I think it was kind of—that was our professional development. So we would organize the workshops and bring in experts, and then learn just as much as the Noyce scholars at times.—Participant 1L*

***Their student teaching seminar, which in our parlance is called Teaching for Learning 2, that was a course buyout so that could be strictly a science-specific section.** Typically those are interdisciplinary. You have students from physical ed, from art, from English, from history, all in the same class, and one of the things we wrote into this grant was the needs of science student—preservice teachers in science—are specific enough that a subject-specific section of that course would be worthwhile, and indeed we've found that's been a successful part of our program. I don't just say that because I'm the one teaching that class, but it's allowed us to really have some control in shaping their experience and to help them interpret what they're seeing in schools and to give some science specific instruction. It's almost served as an advanced Methods of Science teaching course.—Participant 1I*

Retention

Only 10 of the interviewees mentioned promising practices around retention, and when they did, they tended to touch on the topic briefly. This might be because, since most of the interviewees were talking about preparing preservice teachers, they may have seen retention as an issue that was somewhat outside of their influence. However, participants did mention several factors that they saw as contributing to teacher retention.

One promising practice highlighted by participants was to pair preservice teachers with quality cooperating teachers in high-need schools for fieldwork. The mentors' teaching styles should be aligned with the teaching practices promoted by the preservice program, such as inquiry-based learning over lecturing. Strong partnerships with school districts help in identifying strong mentor teachers. Urban teacher residency programs are one such model of this approach. The following quote illustrates this idea.

The key is getting them into a school that's high-needs with a strong mentor. ... I think with my first grants, we were in high-need schools, but their mentors were not very good, so they didn't really learn how to teach well. So now we're in high-needs schools with strong mentors ... and you'll see our final report, because we're coming up on our final report. Our retention is amazing. These folks, they're doing well with their teaching.—Participant 1F

Another promising practice mentioned by interviewees is to provide extended induction support, including faculty mentors and ongoing professional development, to help teachers persist through challenges and think of themselves as lifelong learners, as explained in the following quote.

*If a teacher is struggling, we'll get them resources. We'll find a conference seminar or something to send them to, but the idea is, again, **induction support**; that we want them to stay in the school, and we want them to be successful and feel like they've got a team supporting them and helping them so they're not alone.*—Participant 1C

Participants also suggested that programs can focus their recruiting efforts on prospective teachers who are likely to stay in teaching, such as teachers who care about children, and career changers who are older and chose to give up their old jobs to become teachers. Furthermore, programs can help preservice teachers persist in getting their credentials by giving them scholarships and helping with certification requirements.

Certification

Five programs felt that it was important to help their Noyce scholars meet certification requirements. The specific supports ranged from courses designed to help prospective teachers prepare for certification exams, to helping teachers prepare portfolio and performance-based assessments for certification, to general coaching to make sure the scholars are meeting all certification requirements.

Findings About Contextual Challenges

Nineteen out of 20 interviewees mentioned some type of contextual challenge that they encountered in implementing their Noyce and STEM teacher preparation programs, with the most common challenge being recruitment issues, and other challenges including state and

district policies, teacher and Noyce scholar retention issues, the university context, working with diverse populations of K–12 students, and induction issues. Below are details about what types of challenges the interviewees mentioned, in order of the most frequently mentioned themes.

Recruitment Issues

Eighteen participants mentioned recruitment challenges related to their Noyce scholars and STEM teaching. Many of the participants mentioned recruitment as one of the biggest challenges in implementing their Noyce grants, and discussed how they were far below their recruiting targets. Interviewees bemoaned a lack of knowledge of effective recruiting methods in the field. The most common explanations were the low status of teaching in our society—and even among some of the university faculty—along with the low pay of teachers, especially in comparison to the many lucrative careers available to STEM graduates. Interviewees viewed this as an important societal issue affecting the entire field of STEM education. Other recruiting challenges related to the low status and pay of teaching include parental pressure to choose more lucrative careers, career changers not wanting to lose income to pursue more education, and competition from other summer internship and scholarship programs. These types of recruiting challenges are illustrated by the following quotes.

I think the harder case to make is that teaching as a career is a satisfying career. That the salary and the respect that you get, and things like that, that's a harder case to make. ... I think that one of the problems we have is that our students who can do physics and math are very talented, you know, who could double major in physics and math successfully and meet our Noyce criteria which is a 3.2 GPA. They're very talented, and so one thing, they could find good, high-paying jobs in industry. ... They come to us with all kinds of other scholarships and grants and don't necessarily need our money. Our money is not that much of a lure for them if you know what I mean.—Participant 2A

*There was also focus on getting minority students to participate, and so we had great diversity among the summer camp leaders and thinking about education and stuff, but a lot of these are first-year college students. They have a diverse background, and there is a lot of **family pressure to say that there's something better than teaching.** And so I think, at that age, they were pressured by that, and they didn't have ... power inside of them to say, "Okay, I'm going to go against what my family and friends think, but do what I think is best for me." So I think we see our MAT students saying, "Oh, I tried that, and now I have to do me." But at a young age, I don't think that they're at that mindset.*—Participant 2B

Taking no income for a year and having to pay about \$15,000 is not a viable option for most career changers.—Participant 2C

Sometimes the recruiting challenges stemmed from issues related to the higher education and grant context. Interviewees mentioned that burdensome course requirements were a disincentive to enrolling in STEM teacher preparation programs (see Policy Context and

University Context, below). Furthermore, some prospective Noyce scholars were having difficulty with advanced coursework. Interviewees noted that the timing of the grant made early recruiting difficult. Another challenge was that recruiting partnerships with community colleges sometimes turned out to be less fruitful than anticipated. The quotes below explain these contextual challenges.

*That tends to be the stumbling block that students run into, is their **upper level math**.*
—Participant 2D

*We talked about having our Noyce scholars or our senior personnel go with our admissions people into high schools and talk about it, but because we're entering our fourth year, by the time these individuals would be eligible to receive funding, we're going to be through our cycle. ... **I don't feel that ethically we can go in and try and recruit and make some promises for a program that may not be there when those students are juniors and seniors.***—Participant 2E

So we expended a great deal of time and effort on this community college recruitment piece, and it really didn't pan out, and for some very interesting reasons. One was that—just from a timing standpoint, this is just a five-year grant. So if somebody hears about it as a community college student, they first have to finish their community college degree. They have to have enough credits to transfer into a major at [the university] and have a high enough GPA. They have to then apply for the teacher education program at [the university].—Participant 2F

Another set of recruiting challenges revolved around issues of class and culture. Programs had difficulty recruiting local and indigenous teachers, particularly in Alaska and Hawaii. Prospective Noyce scholars were sometimes afraid of the two-year commitment to teach in a high-need school, with the risk of having to pay back the scholarship if they did not follow through. On the other hand, some Noyce scholars treated the program as a loan or summer internship with no intention of teaching in a high-need school. Finally, interviewees reported a few prospective Noyce scholars feeling that they did not need the scholarship funds, so they should go to “needier” candidates. The following quotes include examples of these types of recruiting challenges.

*You've got people coming in that are a little older, maybe a little savvier about what's going on, and some of them are like, “Yeah, I really value what you're doing,” **but that two-year commitment to high need scares them sometimes.** So there's been years when I can't give away the money. They'd rather pay it out of pocket than risk having to pay it back.*—Participant 2G

*The biggest challenges for me arise with **teacher candidates trying to use the program through their own means. Not because they're committed to teaching high-need communities, but because they see it as like a loan program.** “Well, I'll just get this scholarship, and I'll pay it back later.” Or, just recently, we had a student—she basically*

just did the program for the research internship and then she dropped out of the program. So yeah, and that's super frustrating, just because I feel like I'm not in this to just offer you a summer job or whatever, I'm in it to prepare teachers for these communities that really need them. And I think they know that when they do that, they take money away from a teacher who is actually really committed, but they don't care.—Participant 2H

We actually have students who will take part in our resources but they feel like they don't need the stipend, and they won't accept the stipend. ... They directly say this. They don't need the money and they'd rather have the student that needs the money to take the scholarship.—Participant 2I

Sometimes the recruiting challenges were more personal. If a few prospective Noyce scholars do not enroll for personal reasons, it can have a large impact on meeting recruiting goals, because many of the Noyce programs are quite small. Participants also speculated that many college students were too young to consider teaching, since they just graduated from high school. Finally, interviewees noted that some prospective Noyce scholars were just not well-suited to working with children. The quotes below include explanations of these personal recruiting challenges.

*Another thing that we have found out, and we do have some data to support it, is that **students are not thinking about going into teaching in sciences until maybe their junior or senior year.** And that might come with maturity; you know, you come in as a freshman, that's pretty close. How can you think that you really want to be a high school teacher when you just got out of high school? Unless you have really a lot of confidence in yourself and your abilities in the sciences, how can you think when you come in as a freshman and get hit with freshman everything here, you know, your freshman science courses, which could be a challenge ... Why do you think that you're going to have enough confidence to be able to teach this to somebody else?—Participant 2J*

When you have numbers that small, if you have somebody decide that they're going to go to China for a year and have an adventure, it makes a difference in your total numbers.—Participant 2K

We've had one intern in particular, you know, his applications were glowing, his essays were phenomenal, his references were great, but when we saw him get in front of kids, it was really bad. I mean, I don't expect them to be skilled teachers at this point, but I do expect their hearts to be in the right place; and he was kind of just mean-spirited and not great with kids. And I'm like, you know, this isn't really the profession for you.—Participant 2H

Policy Context

Fourteen participants mentioned challenges in the policy context, meaning state and district policies around STEM teacher preparation. Given state differences in policy, some of the

specific challenges were unique to each interviewee, but most of them revolved around the challenge of having Noyce scholars and prospective STEM teachers fulfill numerous certification and credentialing requirements in the allotted timeframe. Some of the challenges involved the intersection of certification and coursework, for instance when the coursework required for certification interfered with other program components such as extended fieldwork, state-required masters-level coursework for certification costing teachers too much money, and burdensome certification exams interfering with coursework. Heavy certification requirements also put a burden on induction, and getting career changers to qualify for alternative certification. Some interviewees mentioned that the ways teaching certificates were classified could be problematic as well. For example, many areas do not have certification for computer science teachers, despite district demand for such teachers; many make it difficult to teach out-of-license or to get certified in multiple areas due to heavy coursework requirements, which can be problematic for small schools in rural areas; and some do not have subject-specific certification for middle-school teachers. The examples below illustrate some of these challenges around certification.

*We had two years of supporting the one-year stipends with the career changers and the state ... changed the rules for that program for alternative certification, and even though we did go through the process to get approved to be able to run the program, it now went from a one-year program to a two-year program, and it was just very—our **Education Department and the provost and the president thought that it was just not cost-effective to continue doing that program because of the additional requirements that the state had put on it.**—Participant 2J*

*The State ... Board of Education just recently changed the licensing requirements for middle school. It used to be that people getting their secondary teaching credential could do a middle-school endorsement, because they wanted to be a middle-school math teacher or whatever, but they wanted to be a math teacher, so they were majoring in math, but they wanted to teach middle school, so they would get the middle-school endorsement. **Well, the State Board got rid of the middle-school endorsement. They totally rewrote how middle school is credentialed and lumped it in with elementary, which we all feel is a total mistake and going to be a disaster.** ... Quite a few preservice teachers who love their subject, and they really want to deal with middle-schoolers and they're torn, because they can either major in their subject—major in math or biology or whatever, and teach high school and not deal with middle-school students, or they can major in elementary and specialize in middle level, but then they have to relinquish math or biology or whatever it is. It really reduces our pool of people that we can recruit from, because those people who really want to teach middle school, they have to now—they're an elementary ed major.—Participant 2H*

Retention Issues

Fourteen participants mentioned retention challenges related to STEM teaching. These types of comments included both the general issue of teacher retention in teaching jobs, and the issue of retaining Noyce scholars in the program until they become certified. Regarding the issue of

retaining Noyce scholars, many of the comments echoed the themes in the Policy Context section, above, and the University Context section, below, about burdensome graduation and certification requirements causing prospective teachers to drop out of the program. Participants also mentioned prospective teachers failing certification exams; prospective teachers having academic difficulties with advanced coursework and not being able to meet Noyce program GPA standards; personal issues such as family and health problems causing Noyce scholars to drop out of the program, especially if they are from high-need populations themselves; teachers quitting their jobs when they do not value teaching as a profession and do not pursue it as a first-choice option; and low teacher pay leading to teacher retention issues. The following quotes illustrate some of these retention challenges.

*Students' academic performance is all over the map. Some of them are great. Some of them are really strong, and some of them are not. ... We work with a lot of students who have huge, complicated pressures on them. I think of one guy who, right now, is doing a summer internship at our local middle school who is super, but who is the child of undocumented immigrants, one of whom has cancer, who has two young siblings who live down in [location], and is frequently needing to go home to help his family. And this guy, we assumed, would be in the credential program this year, and he forgot to apply. We're like, "What do you mean you forgot to apply?" I mean, we're sending emails constantly. So **I guess part of our challenge is we give out lots of good advice but getting people to hear it and take it is sometimes harder than you would think.** So students have complicated lives, and they're juggling a lot. One of our challenges, I guess, is figuring out not only how can we help them, but how should we help them? What's the right boundary between providing the support that will make the difference in helping somebody to be successful and recognizing that people are dealing with their own complicated lives and needs and decisions, and you can't control them.*

—Participant 2K

***Keeping them in may be a problem because [this state] doesn't tend to support teachers very well.** The surrounding states seem to pay a little bit better. They may go up to other places but as long as we get them out there, we still feel good about it. But as far as keeping them in our particular program, as far as keeping them to tutor other students and help other students as well as receive help, we know that it's critical that they prepare for these exams. So they tend to just not keep up with what they need to be keeping up with when they finish these courses. They tend to forget too quickly.*

—Participant 2I

University Context

Thirteen participants mentioned challenges in their university context. Similar to the policy context comments, a number of the interviewees mentioned that university requirements for prospective STEM teachers were too intensive. For example, some universities require that all prospective teachers major in education in addition to content or instead of a content area. Some require students to take education courses early or late in college, or fulfill a high number of education credits, which impacts recruiting and time to finish the degree. At the

postgraduate level, some universities require a two-year Master's Degree in Education, as opposed to just a one-year post-baccalaureate program. As noted above, some interviewees mentioned that it was difficult to fit in fieldwork, especially extended fieldwork, with content-area and other coursework requirements. The following quotes include examples of challenges around university coursework and major requirements.

*One of the deans in the teachers' college decided that if people were going to get certified, they had to major in education as undergrads. So **now if people want to actually get a math major and get certified, they have to do a double major, which is more credit hours. It's about 150 credit hours instead of 120 at the undergrad level.** So that really discourages people from doing a double major in math and education. ... The faculty directly involved, who would teach the math courses for undergraduate preservice teachers or teach the methods courses, they were all against this move. They thought it would be ideal if everybody were taking enough math courses to be a math major and doing all the education courses without having to do the whole double major. But this was a dean-level decision that we were not able to change.—Participant 2C*

*I think, **in our university, the move to this year-long student teaching has been a challenge for us** because it was mandated at the board level and it's a small state and so we have one governing board for all the public universities. ... And so we had to make some compromises within our STEM content programs to make it work so that students could, in theory, complete it in four years still. And because they wanted a year-long student teaching, but they didn't want us to add an extra year. So we've had to try and get those content courses within the first three years, and that's pretty challenging for STEM majors because a lot of stuff is sequential and built on other things, and if you have lab classes, it's hard to fit everything in.—Participant 2L*

Many interviewees also mentioned tensions between the content-area departments and the education department. Sometimes there was a general lack of communication or coordination between education and content-area departments. Interviewees also mentioned that education departments do not always prioritize STEM education—for example, due to enrollment or budgetary reasons. On the other hand, interviewees also discussed issues with the content-area departments, such as getting broad buy-in from content-area professors around the idea that teaching is a valuable profession, and that it is important for teachers to engage their students, not just know their content area. Finally, it was mentioned that the university moving science education courses from content-area departments to the education department can be problematic because it makes them less discipline-specific. The quotes below illustrate some of these tensions.

Our education department has been—has felt budget pressure, and their response to the budget pressure has not necessarily—has not been to prioritize math and science, in part because math and science have always been relatively under-enrolled.—
Participant 2K

Well, one of the challenges we have was actually with our math department in that they were trying to get everybody to go for a PhD instead of into education. So finding the right person to work within the department that would promote that rather than just the PhD, because we actually had one student that had signed up and then right as she was about to get her first—you know, go through her orientation, the day of orientation she called me and said, “No, they think I should go for a PhD instead.” Like, oh my gosh. So that was a bit of a struggle.—Participant 2K

We’re currently undergoing a second revision to our curriculum, because they’ve decided to take our education courses and move them over to College of Ed. I’m concerned with that, because I feel like, prior to this, developing strong PCK in a content area, whether it’s biology, chemistry, or physics, has allowed them to not have to worry about generating lessons or instructions so much, and they can focus on the other needs that are challenges in those high-need schools. You know, like, “I have this great lesson, okay, now how can I modify it to meet my students’ needs and what they know?” ... So I’m concerned that if we move away from this chemistry, physics, biology type of preparation that we’re giving our students currently, that is going to become an additional challenge.—Participant 2B

Although participants were asked about faculty professional development in the context of the Noyce grants, none of the interviewees said that their budgets allowed for professional development beyond occasional travel to conferences and bringing in guest speakers that the faculty could learn from. Faculty professional development did not seem to be a priority for universities in general. For example:

*So our Noyce program did not have a specific professional development for any faculty ... these were all people who were co-PIs in the Noyce grant, so in some sense, we had had plenty of conversations, but not any formal professional development. Then, **in terms of the university as a whole, there’s not a lot offered for professional development.** The past few years, the universities had a grant, which has offered professional development that’s been targeted at STEM faculty. But I’m not sure—I don’t have control over who chooses to do that or not, so I would say it hasn’t had a big impact on preservice teacher preparation.—Participant 2C*

Diversity Issues

Although a number of grantees have developed promising practices to help prepare teacher candidates to work with diverse learners (as described on pages 11–14), seven participants mentioned challenges relating to prospective STEM teachers’ work with diverse populations of students. These mostly related to cultural differences between often White, middle-class teacher candidates and their often low-income or ethnic-minority students, such as teachers not being familiar with their students’ cultures, teachers quitting due to “culture shock,” or teachers being afraid to teach in urban areas. This was particularly an issue in areas with large indigenous populations of students and few indigenous teachers, such as Hawaii and Alaska, as described in the promising practices around diversity mentioned above (see pages 10–13). As

previously mentioned, interviewees also had difficulty placing student teachers with high-quality mentors in high-need schools. The following quotes illustrate some of these challenges around teaching diverse learners.

*I really wish there was more out there on preparing White teachers for teaching in minority settings. **There's a cultural divide or gap, and teachers need to be prepared to deal with that in a productive way, and they're not.** There's just not a whole lot—and I think even when we go observe in classrooms, like most practicing teachers are not doing a very good job of it. I don't know, I feel like it's just really missing from the literature. When I teach this Noyce seminar, I'm just kind of making it up, because there's nothing much out there.—Participant 2H*

*There's a stark difference between suburban/rural and urban schools. **The challenge is the perception that urban areas are crime-ridden.** Parents would not allow them to go on practicum experiences in [an urban area]. It's a perception of how people view urban-area schools.—Participant 2M*

Induction Issues

Six participants mentioned induction challenges related to their Noyce scholars and STEM teaching. Most of these comments mentioned the difficulty of supporting Noyce scholars and graduates once they leave the university, despite the fact that the induction period was discussed by interviewees as a crucial time in the career of a teacher. As mentioned above, some states place time-consuming demands on new teachers by districts, which do not allow time for much interaction with the university during the induction period. New teachers can be overwhelmed by the difficulty of classroom management and other first-year pressures. Participants also reported having limited funding for induction activities due to graduates not paying tuition during induction period, and districts not providing induction funds to universities. Some of them felt that it was difficult to keep in touch with Noyce scholars in their induction period after they graduated, especially if they ended up teaching far away from the university. The following quotes describe some of these induction challenges.

*As a university with a history of teacher education, we really see a role for supporting teachers beyond that initial certification and it's a tough nut to crack, because once they leave us, once they get certified, they're not still paying tuition. But if we're judged by the quality of our graduates, we know that support during those first few years is absolutely crucial. For these four grants ... building in funding for induction, we saw that as critical. ... **I think there needs to be much deeper state support for teacher induction than currently exists. I really think it can't be funded out of tuition or the universities.** There's just not a mechanism for that to happen. So it's going to continue to require grants.—Participant 2F*

*So another thing that's really specific to [our state], and particularly in this area, is that new teachers are required to do a fairly intensive two-year induction program that is sponsored by their school district. ... And so our problem was our **folks felt like they were***

drowning in kind of required meetings and the kind of support they were getting was not necessarily what they needed more of.—Participant 2K

Findings About Grantee Use of Research

Research was discussed in some capacity in all 20 interviews. The research-related themes that arose in the interviews included the evidence base for their STEM teacher preparation programs, types of data collected, research challenges, research questions posed by the interviewees' research, research questions they would like to see addressed in the field, suggestions for AAAS supports for research, and dissemination. Below we discuss details about the role of research in the interviewees' Noyce projects, in order of the most frequently mentioned themes.

Evidence Base for STEM Teacher Preparation Programs

All of the interviewees said that their program was based on some type of evidence or standards. The most common type of evidence they relied on was outside research, such as the normal reading of journals that they do as professors. A number of interviewees also mentioned standards, such as NGSS, and internal research and evaluation, such as lessons learned from prior Noyce evaluations. The following quote illustrates a typical comment about the evidence base for their programs.

*As a math educator myself, I and the other faculty in math education—**we're very knowledgeable about the research in math education, and we do model our program after best practices based on our own research, based on the research literature that's out there, based on standards documents.** ... We would use the Common Core standards—state standards in mathematics. We use the NCTM Principles and Standards for School Mathematics.*—Participant 3A

Data Collected

All but one interviewee mentioned some type of research or evaluation as part of their grant, although most of it focused on the Noyce scholars rather than the students they taught. The types of data collected ranged from surveys, assessments, and interviews, to classroom observations. The quotes below include examples of the kinds of data that interviewees collected.

***So we involve our Noyce teachers on the instructional team and we've collected a lot of survey and interview data from the teacher participants and from the elementary students.** We've been collecting kind of an individual achievement test to be able to provide information there. That grant also has funded some math coaches at the*

elementary school, so we've collected a lot of data around the impact of those math coaches and some other professional development opportunities.—Participant 3B

*We also have **edTPA data**. ... **It's basically the teacher performance assessment where they have to have some video instruction**. There's planning, instruction, and assessment, and we track how our candidates do on that assessment. Then we also do **interviews with our candidates** to kind of get their self-assessment of how their teaching has been going, what the preparation was like, the recruitment process, but those—you know the Noyce reporting is more bean counting than anything else. It's not really—it's not an in-depth research program like what I think we're all hoping to get at.—Participant 3C*

*We, of course, try to gather as much data as we can. Even for this one [we] have a program evaluator but, yes, **we definitely want to measure program implementation, how did it work, how did it serve the students, but we also want to gather data on the impact of our students in the school**. So what impact do our students have on their students ... maybe interviewing some of the students in focus groups, and then also interviewing and looking at school leadership and do the upper teachers help prepare our students for the teaching job. So it's very important. The most important piece is do our students have an impact on students' engagement in STEM. The big question is also do we want to measure our students' achievement with a longitudinal test ... So that's a problem. To measure our student performance, the impact of our students on student achievement is very difficult, because too many other factors play a role. But what we can measure is the student engagement.—Participant 3D*

*We are collecting all the **classroom practice data**. So we go out and observe the teachers two or three times a semester. And then from there with video, we have a variety of protocols that we use to look at the level of reform teaching, the level of culturally relevant teaching, those kinds of things. We also have the teachers make lesson plans. Every time we do an observation, they do an interview with us. So we're accessing information around that belief by students and teaching and learning. So it's a variety of data that we're collecting in that space.—Participant 3E*

Research Challenges

Sixteen participants mentioned challenges associated with conducting research in the context of Noyce grants, with the most common complaints being that there was no time or money to allocate in the grants for research (as opposed to external evaluation) outside of the research track, that it is difficult to get permission from districts to access student data and conduct school observations, and that the small number of participants in the Noyce programs leads to sample sizes that are too small to get published or use to apply for research track Noyce grants. A few participants were able to get around these limitations by using graduate students to conduct research, and partnering with other institutions on Noyce research track proposals to overcome sample size issues. The quotes below explain some of these challenges.

Research is expensive, and our state is one that is looking at massive budget cuts right now. Our two-year budget shortfall as a state is going to be about a billion dollars, and the university is looking at 5- to 15-percent cuts in different areas. And so when all those things get cut, you lose a lot of the support for research, and graduate students have to get pulled to teach classes; and without having a lot of graduate students, it's really hard to go collect enough data, like enough observation or interview data, to understand what's happening in certain areas. So having grant support to do research that can support graduate research assistants or can buy out some faculty time to be able to collect and analyze data, that's a really important thing to help research get going.

—Participant 3B

The trick is, how do you measure the quality of a teacher education program?. I've done a fair amount of work in this area, and I still don't have a good answer. I like—retention numbers are great, particularly if you can retain students in a school that's been designated from the government somehow as a high-need school. So I think retention is great as an indicator. I'm less excited about teacher quality measures, like the teacher evaluation scores, but in some respects that's almost a moot point, because that data is simply not available to us. Having a sense of how that data is generated in the first place, in the schools, I see so much gaming of the system by administrators that I give very little credence to those.—Participant 3F

*I think sometimes NSF ... they react very positively to **unrealistic expectations**. When in the proposal, it is proposed to measure the impact of our student teaching on students' achievement, and then come up with all the cool things we want to do, and response rates will be high ... but how realistic is that? Is it maybe better to scale down a little bit and measure student engagement, and accept this also, and not constantly be pushing out to the real science data collection. The best thing is, we can have is a control group, which is very, very difficult to do. So it's a little bit because in the educational sciences it's kind of unethical to withhold good teaching from students, and to find a real, as they call it, "control group" in these little villages makes it very difficult.*—Participant 3D

*So we're getting mixed results in the classroom visit request. **How do we actually get someone from our campus and the partnering school and the partner student, our past scholar, to schedule coordination, permission to be on the campus community, or permission to be at the school and do observations?** So we're looking at all the different privacy aspects to it. So we're trying to work through some of those. Different school districts are a little bit more strict than others about having a visitor come in the classroom.*—Participant 3G

*I'll leave it at this, with the Track I and II—probably the III, I don't know as much about Track III—is most of the money, 80 percent of money, is going to stipends, right? For teachers? So that leaves you with 20 percent to run the program and do research. Well, **you're not going to get research done with 20 percent of the budget. So Noyce is just***

not funded to do research. ... We were not allowed to have any money towards faculty or graduate students. So I had 90 percent of my money going to stipends for teachers and 10 percent going to an external evaluator, and there was zero money for my time or for a graduate student. So any research that happens then just comes out of my own hide. So now it has shifted now to 80/20, but still, research takes time, and it's not being budgeted for in the Noyce budget. ... And again, a good external evaluator is worth their weight in gold, no question, but it's not going to generate research, and it's not going to end up in research journals. That's not their goal. That's not what they do.

—Participant 3E

If you're going to do much [research], you have to build on some existing work that's out there and just do kind of a little piece that's tied to your project, because there's not enough money in the grant. I mean, **we're required to spend some huge percentage of the money on scholarships, and so there's not that much left over for other things.** ... Given the nature of education research, it's expensive. It is way more expensive than the science that I did as a scientist, and way more complicated.—Participant 3H

One of our biggest challenges is sample size, because each group is only 10 to 15 people. So I feel like that's a persistent challenge that can't really be addressed.—

Participant 3I

Research Questions Posed by Participants' Research/Evaluation

Fourteen interviewees mentioned the specific questions they were addressing in their research or evaluation, with most of them centered around the instructional strategies that the Noyce scholars were learning to use with their students, such as inquiry-based instruction. The interviewees were mostly interested in learning about whether their scholars were implementing those strategies, or whether those strategies were having an impact on the achievement and engagement of their students. How to effectively teach diverse or high-need learners, such as English Language Learners, was another type of research question mentioned by interviewees. The quotes below provide examples of the specific types of questions participants addressed in their research/evaluation:

We want to know how are the participants in our program changing over time? And how do certain things that we're doing influence the development of teacher leadership over time? So there's kind of two prongs to this. One is focused on the teachers that went through the teacher leadership endorsement and how their view of the profession has changed, and then, secondly, it's how does teacher leadership develop among our preservice and induction teachers? So are they able to kind of pick up on some of these teacher leadership things over time, and do we see a change in the style of leadership that they're engaged in? You know, do they go from being kind of this passive leader where they don't think they have much power to somebody who has power. And we're looking to see how that might not bond to things like self-efficacy and how they perceive themselves in the classroom.—Participant 3J

We did focus our research on **what was the best pedagogy to impact student learning** and we looked at even using manipulatives, and which ones, and how to effectively use those different strategies. Like we have a lot that, “Oh, I can use manipulatives, yeah,” but if you’re just using it as a toy, it’s not being effective. So we really focused more on the pedagogy part for ours and how to effectively use the different strategies to enhance the learning.—Participant 3K

What our research component is doing is **looking at recruiting**; a longitudinal study that’s **trying to identify what things that we are doing that have had the most positive impact in these teachers, our alumni, our past scholars, development, their careers.** What are we doing right, essentially.—Participant 3G

Research Questions Participants Would Like to See Addressed

Fourteen interviewees mentioned research questions that they would like to see addressed in the field, with the research questions that interested them varying. Popular topics included the effectiveness of instructional strategies that the Noyce scholars were learning to use with their students, how best to support Noyce scholars in becoming successful teachers, effective recruitment strategies, and how to promote cultural competency in teachers. The following quotes include examples of the kinds of research questions interviewees were interested in.

How important is it that teachers are prepared in discipline-specific methods courses versus just regular science methods courses? Because I went through a science methods course and that’s probably why I’m in higher ed, because I was like the only chemist in with 15 other biology teachers, and I didn’t really learn how to teach chemistry, per se. ... **What are best practices for recruiting the undergrads? Are certain types of schools more successful than others? Are certain regions of the U.S. more successful than others?** What are the things that play out to make recruitment of undergraduates successful?
—Participant 3J

I would really love to see—and I know, for us, it’s hard, because we can’t get student data—but I would really like to see how the scores—like, **how the students are actually responding to the different strategies we use.** Like, we have the new Common Core out here, but I’d like to see the numbers on how it’s really impacting the students.
—Participant 3K

Well, I’d be **interested in what kinds of areas [teachers] feel they need more support, so that we can make sure that’s in our program.** When we had our summit, ... I spent a lot of time talking [with district partners]. But I talked about how we really need to spend more time together to find out specifically what our teachers need. What can we do, and how can we work together? ... I would like to see the research continue to **study the impacts of the stronger partnerships with school districts,** and have them communicating their needs to us and us implementing; and then, what are the results of those.—Participant 3L

How could we foster a better interdisciplinary approach compared to single-subject area certifications? *Is that even what we want? I don't know. How to move from a single subject area to a more interdisciplinary knowledge around what a teacher actually needs? For teachers, it's very important. If you want to implement the cross-cutting NGSS, the new cross-cutting measurement science standards, you need to have interdisciplinary knowledge. ... So what can a Noyce scholarship do to facilitate a better interdisciplinary knowledge for teachers?*—Participant 3D

I'd love to find out more about attrition. *So what are the major components that lead to teacher attrition, and maybe they're the same as overall teacher attrition? Maybe STEM is different. Are there specific things within STEM teacher careers that lead to their attrition rates being the same, or being different, compared to other disciplines? So is it the classroom? The students aren't prepared? The resources aren't there? Is it looking at what you're expected to teach to your biology teacher or biology major? Is it that you expect them to teach chemistry and possibly earth science?... The group that I was focused on was faculty professional development. The consensus was, there really isn't any. It is like, "Oh, you have a PhD? You must be ready to teach." And some people have a background in K–12 teaching, but a lot of them don't, and so **what kind of professional development do faculty need, and how do we induce people to do this and even see that they need professional development?***—Participant 3G

It's easy for someone to stand up there and say, "We need our beginning teachers to be culturally competent." I agree. How are you going to do it? What works? What doesn't work?... *We've got to stop just focusing on things like retaining teachers. Yes, we need to retain teachers, but we want teachers to grow as practitioners in that time. So I'd rather think about **how do we facilitate professional growth through the induction period.** Not just, "How do we keep them in place?" Because that leads to just attending to people's social/emotional needs and not worrying about what they do. "Let's just keep everyone's emotions in check and make sure they stay." Well, that's only part of the problem.*
—Participant 3E

AAAS Supports

Thirteen interviewees made suggestions for additional supports for research they would like to see from AAAS, covering a range of topics such as more small meetings or working groups among Noyce recipients, support for dissemination through conferences and advice about where to publish their findings, encouraging more qualitative research, helping to elevate STEM teaching as a profession, and adding more resources to their website. Interviewees appreciated the opportunity to meet with district representatives in the regional meetings, and felt that small meetings could be more focused and engaging, and could help continue the momentum and connections that were created in the annual meeting. The meetings could include working groups around topics like research and science teacher education. Additional resources on

the Noyce website could include sample contracts, syllabi, instruments, and research findings. The following quotes illustrate the suggestions that interviewees made about AAAS supports.

*I think **the regional meetings** were a great idea to get people collaborating. One thing that, out of that, there should be research projects. That's the thing that 100Kin10 did. We have our annual summit, and then they're having these collaborative groups, and I'm leading the one on science teacher education. I think some **follow-ups across regions**, maybe get some of the folks from different regions working on a certain task around teacher ed, I think that could be very powerful.—Participant 3C*

***How do you make policy changes with the findings that we have? Like, how do you make that next step to have a bigger impact?** Because I don't know that policy is always—that they're always aware of the research that's taking place. ... Because I can think, okay, now that we know teacher leadership looks like it's kind of important, how can we institutionalize this on a state level? Yes, I have a couple of partners that I've been working with, some who are at the state level, but how do we really all get behind this and value it?—Participant 3J*

*I think the best thing an organization like AAAS could do, since they're a big national organization, is **work to change the culture to make the point that education is crucial to our society, STEM education in particular**. We need to get the country, the communities, valuing teachers and education, and developing good teachers, and then letting them do their job without over-constraining them, you know?... And anything AAAS could do to make any of those things happen would be great. Because then I'd be able to recruit more students into a field that was respected. And I think the problem is, more and more in this culture, education and teaching is not a respected profession. That's the problem. It's a political problem really. A cultural and political problem, I think. I can't do much about it, but AAAS has some weight, you know, because they're big. And where's the next generation of scientists going to come from if they don't start with good teachers in high schools, you know?—Participant 3M*

*So I know AAAS has a website, and they have news and events and things, but I don't think that they're capturing **resources**, and if they do, if there is one, then better publication of that fact. I work with another organization that deals with business education, and what they offer is a syllabus and classroom activity repository that any of its members can go through and download copies of syllabi for hundreds of classes, topics. So you log on with your credential. You put in the syllabi key words, whether its course title or active words, and it will give you a list of documents you can then download and amend for your own purposes or activities from the classroom that you can actually just go through and print off and help develop classroom content that way. So if you had that same kind of thing here to support Noyce—because with the hundreds of programs across campus, we all need contracts, we all need to have agreements, we all need to have certain understandings, you know—then that would be very helpful. ...*

That organization is called USASBE. That's United States Association of Small Business Entrepreneurship.—Participant 3G

Dissemination

Twelve interviewees mentioned dissemination, with some of the interviewees discussing dissemination plans, including Noyce meetings; other conferences, such as AERA, NARST, and NCTM; and publications. Some interviewees mentioned that they would like to publish in peer-reviewed journals, if possible, but none of them mentioned specific journals that they were targeting. However, a few interviewees were unsure about where to publish, or whether the data they collected was publishable.

*Some of the other co-PIs on the project have also published kind of revisions to a framework, or maybe a better understanding of what teacher leadership looks like and how professional identities developed over time—so, mainly **at conferences and through journal publications**.—Participant 3J*

*Our stated goal is to work towards a peer-reviewed publication and then see if the data—and we can say that's what we want, but until we actually get the data and work through it, it may not be conclusive enough to go through and warrant full publication. Which in and of itself may be a conclusion that's worth publishing, but you know how science is. **A lot of these things, you only publish what works. You're not publishing things that are unsure, that don't work.**—Participant 3G*

*We're actually working on a paper right now, but that's a question I guess I can ask you. **Are there publications, research publications, coming out of Noyce programs and, if so, do you know where they're publishing them?** I mean, I've asked that question at meetings before with the Midwest Conference, like, okay, are people publishing? Where are they publishing? And I can't really ever get an answer. So I'm very curious, and very interested in that aspect.—Participant 3N*

Summary

This report summarizes findings from baseline interviews with Noyce grantees relating to three main areas of STEM teacher preparation: Promising Practices, Contextual Challenges, and Grantee Use of Research. Interviewees reported a variety of promising practices in relation to the following aspects of their program: recruiting, collaboration, fieldwork/induction, teaching diverse learners, technology, instructional strategies, retention, and certification. Interviewees also reported a number of contextual challenge that they encountered in implementing their Noyce and STEM teacher preparation programs, with the most common challenge being recruitment issues, and other challenges including state and district policies, teacher and Noyce scholar retention issues, the university context, working with diverse populations of K-12

students, and induction issues. The research-related themes that arose in the interviews included the evidence base for their STEM teacher preparation programs, types of data collected, research challenges, research questions posed by the interviewees' research, research questions they would like to see addressed in the field, suggestions for AAAS supports for research, and dissemination.

Interviewees made suggestions for additional supports for research, covering a range of topics such as more small meetings or working groups among Noyce recipients, support for dissemination through conferences and advice about where to publish their findings, encouraging more qualitative research, helping to elevate STEM teaching as a profession, and adding more resources to their website. Interviewees appreciated the opportunity to meet with district representatives in the regional meetings. They felt that small meetings could be more focused and engaging, and could help continue the momentum and connections that were created in the annual meeting. The meetings could include working groups around topics like research and science teacher education. Additional resources on the Noyce website could include sample contracts, syllabi, instruments, and research findings.

Appendix A
Interview Guide for Noyce Grantees

Interview Guide for Noyce Grantees

Introduction

EDC is a nonprofit research and development organization. We are working with AAAS as external evaluators to document the impact of the ARISE project, sponsored by NSF's Robert Noyce Teacher Scholarship Program. This is the first of two interviews. The purpose of this interview is to collect information about how different Noyce grantees organize their Noyce programs. AAAS and EDC would like to understand what is similar and what is different across different Noyce programs, and compile innovative practices in preparing STEM teachers and teacher leaders. We also would like to understand the impact of the Noyce program on its grantees. Finally, we would like to investigate what is the current use of research among Noyce grantees, and compile items for a research agenda. This is not an evaluation of your program.

Do you have any questions about the interview?

Can we record this interview? [Start recording in WebEx.]

1. Your Noyce Program(s)

Have you had any prior Noyce grants, or is this your first one?

Summarize

Is this an accurate description of your Noyce program, or is there anything you would like to add or elaborate on?

How many teachers and/or leaders are being served by your Noyce program?

How are you recruiting program participants? Challenges?

What are some key successful/innovative practices your program has used to prepare STEM teachers and/or leaders? [Probe for specific course names, etc.]

What are some challenges that you have encountered in preparing STEM teachers and/or leaders as part of your Noyce program?

Who are the high-needs populations your candidates are working with?

What strategies do you use to prepare STEM teacher or leader candidates for teaching specifically in high-need schools?

What professional development, if any, does your Noyce program offer to preservice STEM teacher education faculty?

How do STEM teacher certification and license requirements shape your Noyce program?

What, if any, partners or collaborators do you have as part of your Noyce program? What strategies contribute to the success of those collaborations?

Does your STEM teacher preparation program receive any outside funding other than Noyce? [If yes, probe which ones.]

In which department is your Noyce program based (STEM versus School of Ed)?

How does your preservice STEM teacher education program fit into the larger context of your institution?

In what ways, if any, has the Noyce program helped to shape your institution's preservice STEM teacher education program? How has the Noyce program been effecting change at your institution?

2. Research

In what ways, if any, have you used standards-based and/or evidence-based practices in designing your preservice STEM teacher education program? What are some resources you use to guide you?

If your program includes research, what are you investigating?

What data, strategies, methods, or instruments, are you currently collecting to document the impact of the program?

In what ways, if any, are you sharing findings from your program?

What, if any, challenges has your program run into in conducting research?

What kind of support would you need to enhance your program's capacity to conduct more research in the future?

What types of research questions would you like to see addressed in the future to inform the refinement of your preservice STEM teacher education program?

[Added in late August] Have you considered applying for the research track? Why or why not?

Is there anything else you want to discuss regarding your Noyce program, or how you use research, that we haven't already covered?