E-NEST Remote Learning Transition in STEM Education

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Abstract— **This research analyzes how remote learning models are utilized in STEM Education. The E-NEST project developed online teaching models to instruct teaching interns during the unprecedented times of the coronavirus pandemic including mentorships, internships and culturally responsive teaching summer workshops. Based on key findings from data collection and program evaluations from the National Science Foundation Robert Noyce Teacher Scholarship program, a comprehensive online learning classroom was created to teach cultural diversity in STEM Education with modified project management and recruitment approaches. As a result, E-NEST online internships and professional development workshops were effective and promoted student achievement during the transition to remote learning. The project team learned the functions of online apps to instruct students and gained experience in facilitating online learning classes.**

Keywords— Noyce, online instruction, digital technology, culturally responsive teaching, online project management, professional development, internships, mentorships, summer workshops, data collection

I. INTRODUCTION

The beginning phase of this E-NEST National Science Foundation (NSF) grant faced pronounced challenges due to the unprecedented event of the coronavirus pandemic affecting the entire country. New York City College of Technology (City Tech) and Borough of Manhattan Community College (BMCC) are located in the epicenter of the pandemic in the United States where universities could not continue to conduct in-person classes due to the sudden onset of a national emergency.

The main goal of this new NSF Noyce grant is to recruit and educate prospective STEM teachers for high need schools in Brooklyn and New York City (NYC) public school districts. Since in-person classes were no longer encouraged, STEM faculty from these universities explored methods and found a new approach to train future K-12 educators. Conceptual framework factors influencing E-NEST remote learning were identified and consisted of project management, internships, mentorships, Noyce summer workshops, online teaching and recruitment. E-NEST faculty developed remote learning professional development workshops for college students. The E-NEST project, in particular, implemented specific online teaching models emphasizing cultural diversity in STEM Education.

To support the continuation of teaching and learning, an assortment of new online learning tools was utilized. The two main apps, Zoom and Microsoft Teams greatly helped to sustain the quality of the E-NEST project. Other online tools used for professional development workshops and project management meetings were Skype, Cisco Webex, Google hangouts, Google classroom and Blackboard Ultra. These apps were also used for intern and scholar recruitment and summer internships and mentorships.

All of these online apps offer advanced functions to give interns the opportunity to adapt to remote learning effortlessly. This aided in teaching the best practices in cultural diversity in STEM Education. These online tools were used during the Noyce Summer Workshops which have been offered to teaching interns and scholars annually since the first NSF Noyce grant. Although these summer workshops were not able to be conducted in-person,

the core components of these workshops were still able to be taught excellently.

The E-NEST project team was able to learn the functions of the Zoom and Microsoft Teams apps efficiently and gain experience in facilitating online learning and project team meetings using all other apps. There were numerous advantages of remote learning which will be further discussed in Section III of this paper. We will continue to develop innovative online learning models which will be applied to support all interns, scholars and teachers who will partake in this NSF Noyce program.

During the E-NEST project, Noyce interns and scholars participate in annual summer programs consisting of STEM Education and cultural diversity professional development workshops. Also, they are involved in mentorships with STEM and Education faculty from City Tech and BMCC. At the end of this NSF Noyce grant period, highly effective STEM teachers will be trained to teach in NYC schools where there has been a teaching shortage, specifically in STEM Education.

The rest of this paper is organized as follows: Section II reviews the literature for this topic; Section III introduces E-NEST online learning models to train interns and scholars to become exceptional prospective STEM teachers and to conduct meetings remotely with E-NEST faculty; Section IV presents project data collection and external program evaluations comprised of surveys and interviews from Noyce students; Section V summarizes the findings of this study and discusses potential guidelines for upcoming research.

II. LITERATURE REVIEW

According to [1], the United States has a critical shortage of qualified STEM educators in classrooms, especially in high-need NYC public schools. With uncertified mathematics and science teachers in junior high schools and high schools, students are significantly disadvantaged in learning. Not only recruiting, but retaining STEM teachers in these schools has affected student achievement in several subject areas including computer science and mathematics. The NSF Noyce program at City Tech and BMCC addresses this issue by recruiting K-12 teachers for high-need schools in urban communities.

In [2], these studies have confirmed that teacher turnover rates have had the most impact in high-need communities where students are underprivileged. These teachers often leave these communities to teach in school districts where there is a lower percentage of minority students and higher socioeconomic status. Without competent teachers, student success is difficult to attain in high-need communities. The Noyce program not only recruits, but retains STEM educators by offering supportive and informative training for teachers.

The NSF has developed the Robert Noyce Teacher Scholarship program [3] to assist in recruiting and retaining certified STEM teachers to pursue careers in the United States. The Robert Noyce Teacher Scholarship program seeks to encourage talented Science, Technology, Engineering and Mathematics majors and professionals to become K-12 STEM teachers in high-need local education agencies.

Students are eligible to receive up to a maximum of two years of Noyce scholarship support while they study to become certified to teach a STEM subject. The NSF grant being implemented at City Tech and BMCC has greatly helped high-need schools acquire the certified teachers needed for students in all communities to receive a top-quality education in varied subject areas.

In [7], this research presents the three-tiered project model, Noyce Explorer, Scholar and Teacher, which was used in the previous successful Noyce project at City Tech and BMCC. Additional improvements have been identified and will be implemented in the current E-NEST project at both City Tech and BMCC campuses where they will support STEM students. This project has gained success in recruiting students enrolled in STEM majors to obtain their degrees and teaching certifications, specifically in Mathematics and Technology fields. The previous Noyce NEST project productively trained 20 new qualified K-12 STEM teachers for high-need communities in the NYC area.

In [8], the pedagogy, culturally responsive teaching is recognized and demonstrates the

significance of including this issue in STEM Education. Culturally responsive teaching is essential to create an inclusive classroom where students increase their knowledge and modify their teaching methods. As a result, Noyce workshops including culturally responsive teaching guide students to create an improved classroom culture relating to awareness of race and ethnicity.

[9] discusses how remote learning, specifically the use of videos, has been beneficial during the coronavirus pandemic. The current generation of students are accustomed to the standard of using video in their personal lives and video should be applied more to higher education practices for student success. This research discusses different approaches to use video and technology in the online classroom.

In [10], this research examines online learning across the nation during the beginning months of the pandemic. State education agency policy guidelines by all 50 U.S. states were analyzed. Several areas of consensus were found including cancellation of testing, recommendations to continue some form of remote learning, attention to digital and non-digital options and a fair and appropriate education for all students, including students with disabilities. By providing digital options in schools, diverse learning styles were accommodated and contributed to further student success.

A collaborative effort to support teacher educators is outlined. This includes supporting the instructional needs and concerns of educators due to the challenges posed by the global pandemic at the university level. The School of Teacher Education members formed a remote learning community and developed an action plan and implemented resources. Suggestions in this research can be used to enhance future considerations related to teacher professional learning and preparation.

III. E-NEST REMOTE LEARNING

During mid-March 2020, the coronavirus pandemic affected the United States, especially New York City which was the epicenter of this virus. Due to these unforeseen circumstances, City Tech and BMCC universities could not continue to hold in-person classes and transitioned hurriedly to remote learning models.

Several challenges of E-NEST remote learning were identified involving technological, cultural and personal dynamics. As a result, the E-NEST member committee identified key conceptual framework factors that would affect remote learning during this period as shown in Figure I.
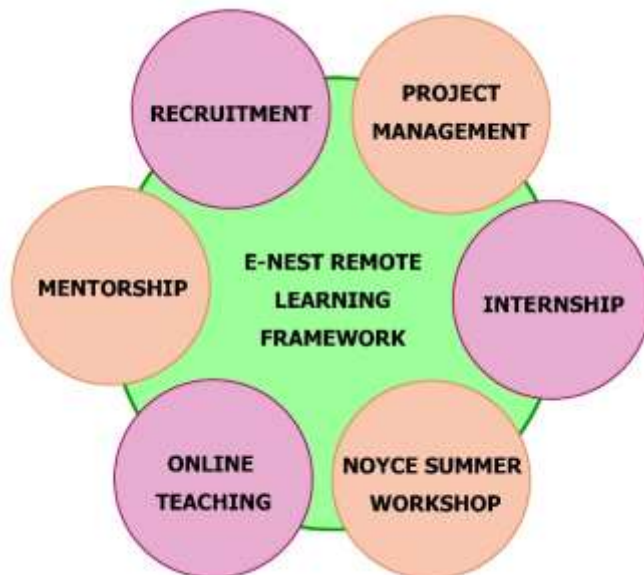

Figure I. CONCEPTUAL FRAMEWORK FACTORS INFLUENCING E-NEST REMOTE LEARNING

With the first year of the NSF Noyce project just beginning, the E-NEST project team used the above model to modify their project management meetings, recruitment strategies, internships, mentorships and Noyce summer workshops involving culturally responsive teaching. Without being able to hold team meetings, recruitment, mentorships or workshops in-person, the E-NEST project management team reconfigured their curriculum to hold all of these project activities remotely for the summer. The two main apps, Zoom and Microsoft Teams were utilized. Other online tools used were Skype, Cisco Webex, Google hangouts, Google meetings and Blackboard Ultra.

Project Management

In-person project management team meetings were not able to be held. Instead, these meetings were conducted using various online tools, emails and phone conferences. Strong leadership from the E-NEST faculty led remote meetings to engage the team and encourage communication. Project

management responsibilities included assigning tasks and monitoring and tracking to make sure team members stayed on schedule. Dropbox and Google Drive were also conveniently used to upload and share files.

The E-NEST project management team adapted approaches to organize the Noyce summer workshops; recruit interns for the summer workshops and summer internships; recruit scholars; facilitate internships and mentorships remotely; and utilize online teaching apps and functions.

Recruitment and Mentorships

Noyce intern, summer workshop and scholarship applications were distributed widely through emails. Varied STEM departments each reached out to their cohort of students. Online seminars and information sessions were conducted online to further advertise the Noyce program to university students.

Materials that students included in their application were: application form, resume, college transcripts, academic recommendation letters and essays. The E-NEST project team met remotely to discuss potential applicants for all Noyce internships, summer workshops and scholarships and conducted student interviews online. Students were selected to participate in Noyce mentorships with professors, internships, summer workshops and scholarships during the summer semester remotely. Online mentorships consisted of individual and group meetings with STEM and Education faculty. Online submission on all student work including project assignments and reports was required. Student field placement records were provided to be completed to log hours and activities completed for internship activities. Remote office hours were provided to potential and existing interns, scholars and summer program students by using waiting room app functions.

Noyce Summer Workshops

The Noyce summer workshops consisted of eight-day four-hour remote learning workshops involving STEM Education subject areas. Topics included culturally responsive teaching, mathematics, computational thinking, introduction to teaching, quantitative reasoning and problem solving, design embedded systems, computer-aided techniques in design and manufacturing and classroom case studies. Hands-on online learning activities were provided where students were engaged in kinesthetic learning.

Benefits of E-NEST Remote Learning

There were several advantages of using the new remote learning models for project management meetings, recruitment and mentorships and Noyce summer workshops.

The E-NEST project team and Noyce students were able to learn the functions of the Zoom and Microsoft Teams apps efficiently and gain experience in facilitating and participating in online learning and project team meetings.

The advanced functions of these apps were valuable for faculty and for students who are already skilled in modern technology apps. Hosts were able to assign other faculty as co-hosts to allow them to use more advanced functions online. Breakout room and chat functions helped better facilitate group and individual discussions. Students were able to ask questions on chat and have faculty address them at a later time during the workshop. Faculty used the chat function to send survey links, website links and reminders.

Online recording of meetings with certain permission was another resource that made information readily accessible for students. Visual aids such as built in tools for screen sharing allowed students and faculty to share information, online labs and PowerPoint slides on hand. Students were able to give presentations online using audio and video features.

Meetings were able to be scheduled ahead of time and recurring meetings were easily emailed to all faculty and students with one link. Attendance lists were automatically generated at the end of the meeting to see which students were present for each workshop. Keyboard shortcuts were also functions used resourcefully.

These apps were convenient for students and faculty to log on from any device and from any location. Making these workshops more accessible for all allows these workshops to host a greater amount of people. Without space as an issue, a larger number of students can be recruited to participate in summer workshops and other meetings.

The Noyce external evaluation was conducted remotely during the Noyce summer workshops by using the breakout room function. The workshop professor helped facilitate students into a separate room to be interviewed by the program evaluator. Survey links were also emailed to summer workshop students to evaluate the Noyce program and give feedback to the evaluator.

IV.   PROGRAM DATA COLLECTION AND RESULTS

During the Summer semester, City Tech and BMCC interns partook in Noyce teaching internships and summer professional development workshops remotely. Students were surveyed online once they completed their internship or summer workshop sessions by interviewing with the program evaluator and/or survey responses.

The findings of this data are based on empirical evidence, which identifies the critical factors of remote learning in the E-NEST program which have contributed to the academic success of Noyce explorers. Based on the results, the respondents generally agreed that E-NEST online internships and summer workshops were effective and promoted student achievement during the transition to remote learning.

Figures 2 to 4 below illustrate significant findings on remote teaching and learning in the Noyce program. In Figure II below, the majority of Noyce students strongly agreed and agreed that the online instruction was engaging and enjoyable.
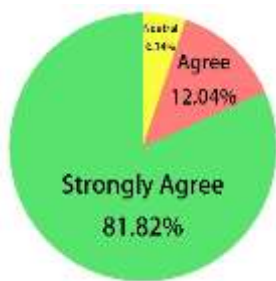

Figure II. Noyce Online Instruction Engagement
Question- The online instruction of the Noyce program was engaging and enjoyable for learners.

In Figure III below, the majority of students strongly agreed that online instruction added higher quality to teaching and learning.
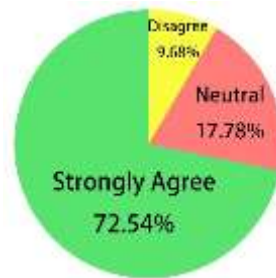

Figure III. Online Teaching and Learning
Question- I think the use of online learning improves the quality of teaching and learning.

In Figure IV below, the majority of students strongly agreed and agreed that online instruction empowered them to differ their pedagogical skills.
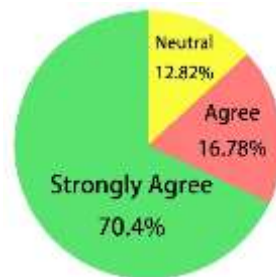

Figure IV. Remote Pedagogical Skills
Question- I believe online learning enables me to vary my pedagogical skills.

This survey data demonstrates that supports for Noyce students including online internships, summer workshop programs and mentoring by STEM and Education faculty have aided students to transition to remote learning successfully. With the E-NEST project officially starting under pandemic conditions, the project team was still able to launch a productive online summer 2020 workshop series along with several teaching internships involving high-need high schools and CUNY professors. Noyce funding has allowed CUNY to continue to encourage talented STEM university students to become K-12 computer science and mathematics teachers.

V. CONCLUSIONS AND FUTURE WORK

In this paper, remote learning models that were utilized in STEM Education were analyzed. The E-NEST project modified teaching and project management strategies to accommodate students during the global pandemic of the coronavirus. Modified teaching and project management strategies consisted of issues on recruitment, culturally responsive teaching summer workshops, internships and mentorships.

In addition, program data collection and external program evaluations were presented. Based on key findings from data collection and program evaluations from the NSF Robert Noyce Teacher Scholarship program, a comprehensive online learning classroom was created to teach cultural diversity in STEM Education along with effective recruitment, project management and mentorship strategies. The outcomes demonstrate that the new remote learning strategies during the E-NEST project were constructive and successful.

This research could be applied to many other similar projects nationwide. For future work, we plan to continue to modify remote learning strategies to apply to the new cycle of the E-NEST project. Also, we will collect additional program data and external program evaluations to analyze results and contribute to future STEM Education projects.

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