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An Online STEM Program for Gifted Students of Color Amidst COVID-19

Crystal Watson

W.E.B. Du Bois Scholars Institute, Princeton, NJ

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ABSTRACT: There is a need to expand the pool of talented science, technology, engineering and mathematics (STEM) professionals who come from underrepresented backgrounds. The W.E.B. Du Bois Scholars Institute's Accelerated Learning Academy (ALA), which operated as a three-weekend online STEM program in 2021, provided high-achieving tenth, eleventh and twelfth graders from underserved communities the opportunity to participate in interactive online STEM workshops within one of four ALA STEM tracks: Applied Mathematics, Artificial Intelligence (AI) and Technology, Medical Science or Biomedical Engineering and Technology. The weekend workshops consisted of STEM guest presentations, a combination of lecture and interactive group activities for practical application, and "New Thinking" workshops to foster collaboration in exploring methods to address contemporary STEM issues. In this paper, I describe attributes of the ALA program that was configured for the online environment and the survey data reflecting students' responses to the program. Survey results showed a heightened awareness of STEM careers after participating in the workshops and an increase in STEM knowledge and skills. Furthermore, survey results indicated that students derived high value in the online workshops' curriculum, working with other participants, and learning from experienced STEM professionals.

INTRODUCTION

The pandemic caused by the latest coronavirus disease, COVID-19, forced many schools, universities, organizations, and programs around the world to modify or even cease in-person instruction to protect the health and safety of everyone involved. Alternative modes of delivery were developed to avoid further disruptions to the workplace and to learning. Distance learning, educational instruction conducted via technology between physically separated teachers and students, became a prominent form of instruction among educational institutions (Moore et al., 2011). This provided students with education in all subject areas, including but not limited to math and science (Johnson et al., 2022).

For many secondary aged students and educators, participating in online teaching and learning during this time was a new experience, providing both benefits and challenges. Online instruction offered opportunities to work from home, creatively use digital programs, engage in self-pacing and cultivate increased responsibility among students (Martin et al., 2022; DeCoito and Estaiteyeh, 2022). However, fostering and maintaining student engagement as well as navigating technological issues proved difficult for instructors aiming to reach students more familiar with a face-to-face format. For science, technology, engineering, and math (STEM) courses in particular, creating authentic laboratory and hands-on experiences, that still included preparation of materials, problem-solving elements and realistic results for examination in an online setting, posed a unique set of difficulties (DeCoito and Estaiteyeh, 2022). Further, when considering students from low socioeconomic backgrounds and communities of color, internet and computer access became obstacles to successfully transitioning to an online environment (National Science Board, National Science Foundation, 2021a; Kelley and Sisneros, 2020). According to Fishbane and Tomer in 2020, Black and Latino/Hispanic residencies fell behind White residencies in broadband connections by 6.8% and 3.4%, respectively. Consequently,

schools' delivery of Chromebooks to students and provisional accommodations from internet service providers assisted these groups to address this gap.

For minority students in particular, including Black or African American and Hispanic or Latino students who are underrepresented in STEM careers, it is important that STEM instruction is facilitated even in an inclusive online environment (National Center for Science and Engineering Statistics, 2021; Bosch et al., 2019). Inclusion of these groups in STEM disciplines can yield advantageous outcomes. Incorporating more populations with diverse backgrounds, such as those with distinct cultural identities, ethnicities, genders, and abilities has been shown to generate more creative ideas and innovations to benefit society (Hong and Page, 2004). Further, cultivating diversity in STEM workforces can not only nurture the talents of a broader range of people, but it can also positively impact the quality of science and help the United States maintain its competitiveness and economic growth on a global scale (National Science Board, 2020; Medin and Lee, 2012).

Notwithstanding the benefits of diversity within STEM fields, minority groups, such as Black or African American and Hispanic or Latino groups are underrepresented in this area. Although these groups constituted 31.5% of the United States population ages 18-64 in 2019, they were inadequately represented in education and employment areas of both engineering and science (National Center for Science and Engineering Statistics, 2021). Correspondingly, according to the National Science Board, National Science Foundation (2021b), in 2019 the percentage of Hispanic or Latino individuals in the STEM labor force with at least a bachelor's degree was 8% while the percentage of Black or African American workers in this field with this designation was 7%. Research suggests that this disproportionate number of minority participants in STEM education and employment can be caused by socioeconomic hindrances, individual barriers (obstacles affecting oneself), and institutional barriers (discriminatory policies or procedures that systematically disadvantage specific groups) (Tsui, 2007).

While some strides have been made in reducing formal and legal obstacles, a focus on minimizing individual barriers can further keep minority groups involved in the STEM pipeline and improve academic and professional outcomes (Tsui, 2007; National Science and Technology Council, 2021) Negative self-perception, or an adverse sense of belonging in education or employment settings is an individual barrier that can contribute to minority disparity in STEM fields. These groups who feel undervalued or unfavorably stereotyped in these settings are likely to either avoid these environments altogether or experience higher stress levels, decreased physical and mental health and lower grades while in these environments, which can lead to greater attrition in STEM pathways while widening racial, gender and social class achievement gaps (Ito and McPherson, 2018; National Science and Technology Council, 2021). One way individuals can embrace a stronger sense of belonging in STEM fields is by physically or even virtually connecting with STEM professionals or mentors who have similar gender and ethnic backgrounds. These supporters, who may consist of faculty, staff, graduate students, postdoctoral associates, or peers is seen as beneficial motivators from whom students can receive knowledge and tutorage from like-minded people. This can foster the belief that they too can undertake and achieve a career in STEM fields (Kricorian et al., 2020). Therefore, programs that offer this physical or virtual interactivity between students and STEM professionals may bolster students' confidence and preparedness for navigating academic and professional ventures.

To further increase interest and representation in STEM fields, it is widely held that promoting STEM education to students at an early age is key. Research shows that high school students who gain confidence in their math and science skills are more likely to pursue a STEM major in college and, ultimately, an associated profession (National Science Board, National Science Foundation, 2021a; Mau and Li, 2018). More specifically, underrepresented groups who participate in accelerated versions of this coursework while in high school are more inclined to persevere in completing their STEM-related baccalaureate degree and pursue a related graduate degree (Foltz et al., 2014). Furthermore, counselors and key stakeholders can lessen barriers to academic and professional STEM endeavors among minority students by providing encouragement and taking measures to bolster self-efficacy among the students (Mau and Li, 2018). Therefore, participation in co-curricular STEM programs, such as the Accelerated Learning Academy (ALA) under the auspices of the W.E.B. Du Bois Scholars Institute (the Institute), that offers an advanced math and science curriculum as well as supportive services, are important for helping minority youth become more interested in STEM, associated careers and remain in the pipeline.

The W.E.B. Du Bois Scholars Institute is a not-for-profit academic and leadership organization for high-achieving middle and high school youth from underserved communities. The Institute strives to lessen the disparities in opportunity and academic achievement that exist in almost all sectors of society and economy by diligently preparing student leaders to excel in higher education as well as professional settings and embrace making a positive impact on others. Under the umbrella of the W.E.B. Du Bois Scholars Institute is the Accelerated Learning Academy STEM program. While open to students from all demographic backgrounds, the ALA focuses primarily on high-achieving tenth, eleventh and twelfth grade students from underserved communities who show high interest in STEM-related fields. By harnessing the under-tapped abilities of minority students,

their experiences and perspectives are nurtured through exchanges of ideas, approaches to solving problems and generating solutions. The ALA program also provides a support network with opportunities for career development and advanced education through interactive STEM workshops for student participants. In doing so, the ALA program aims to keep these students engaged in the sciences throughout their academic years (Cummings et.al, 2021).

In light of COVID-19, the 2021 ALA program transitioned from a residential program, whose workshops were hosted at Princeton University, to a fully online distance learning program utilizing Zoom, the web-conferencing platform. The ALA online program is detailed and evaluated in this paper to address the effectiveness an engaging distance learning STEM program can provide for minority youth.

FRAMEWORK

Accelerated Learning Academy (ALA). The 2021 Accelerated Learning Academy operated as an online program that occurred on three weekends (Friday evenings - Sunday afternoons) throughout the academic year, including a weekend in January, February, and April. During the program, participants partook in a series of career development and interactive academic enrichment online workshops in one of four ALA STEM tracks, including the applied mathematics track; artificial intelligence and technology track; biomedical engineering and technology track; and medical science track. Each track offered a new yet related scientific topic each weekend to build upon the information provided at previous workshops. Therefore, each track consisted of a maximum of 25 participants who enhanced their knowledge and skills by remaining in the same track for all three program meetings. Each ALA track makeup included the following percentage of students: Applied Mathematics (23%), Artificial Intelligence and Technology Track (25%), Biomedical Engineering and Technology Track (26%) and Medical Science Track (26%).

Student Participants. Students from all demographic backgrounds throughout the nation were welcomed to apply for the ALA program by submitting an application, transcript, two letters of recommendation, and a 300-word essay explaining their interest in the program as well as their career and educational goals; eligibility requirements included academic standing as a tenth or eleventh grade student, an overall grade point average of 3.0 out of 4.0 scale and a B average in all of the STEM courses that the applicant had completed. Semi-finalists were then invited to participate in a one-on-one virtual interview with returning program staff, youth educators. Upon review of the applicant's completed application profile, finalists were invited to join the program.

In addition to the tenth and eleventh grade new students (N=70) who applied for their first year in the program, returning students (N=25), current eleventh or twelfth graders who previously participated in the program, were encouraged to reapply by submitting a new application and an updated transcript. Returning students could reapply for placement in the same ALA STEM track to continue their learning or apply for placement in a new track to immerse themselves in a novel area of STEM.

As a result, the 2021 ALA program served 95 students from an array of backgrounds, emphasizing the program's goal to expand interests in STEM career fields among high-achieving students of color from underserved communities. This student population included students from low-income neighborhoods, including but not limited to Newark, the Bronx, Chicago, Orlando as well as other municipalities in the eastern region of the United States (Cummings et.al, 2021). The 2021 participant population also identified themselves as the following racial or ethnic demographic background: Black or African American (41%), Hispanic or Latino (15%), Asian or Asian American (22%), White (19%), Other or Multi-Ethnic (3%). Furthermore, 49% of participants identified as males, compared to 51% of participants who identified as females. This diversity allowed students to interact with peers who not only embodied the common interest in STEM, but who also brought forth differing life experiences and viewpoints that could enhance the online learning experience.

Faculty and Academic Team. Faculty instructors and graduate students taught in the ALA STEM tracks. Faculty, who consisted of advanced Ph.D. candidates and post-doctoral fellows from several research institutions, created and led the STEM workshops. There was at least one faculty instructor in each track. Their expertise lied in the following fields: chemical engineering, physical chemistry, software engineering, computer science, biomedical engineering, mathematics, and molecular biology. Graduate students with backgrounds in STEM were provided in the Biomedical Engineering and Technology Track and the Artificial Intelligence and Technology Track to provide near-peer mentoring for students and teaching aids to faculty instructors. Both faculty instructors and graduate students were recruited via online job postings or recommendations from current and former faculty and staff. After a thorough vetting process, hired individuals were oriented into their roles and compensated for their work during the program.

Oftentimes, faculty and graduate students instructed in the ALA program for multiple years, which fostered prolonged interaction with students who were continuing their education in ALA. Even when the program was not in session, current and former participants were also welcomed to communicate with faculty regarding research, college preparation, recommendation letters and any questions they

developed. Additionally, the majority of faculty identified as women and persons of color, two historically underrepresented groups within the STEM field (National Center for Science and Engineering Statistics, 2021). This also reflected the large percentage of ALA participants' demographic. Diversity among the faculty provided participants with role models who demonstrated that knowledge and success in STEM were achievable.

In preparation for the program's commencement, faculty instructors planned their curriculum months in advance by preparing detailed lesson plans, a comprehensive syllabus, and a materials list for each weekend workshop using Institute-specific templates. All three documents were submitted to the administration to ensure interactivity, standardization of workshop content across all four tracks, and achievement of program goals. In the lesson plans, instructors filled out an hourly schedule outlining the objectives, materials, activities, and readings planned for the workshops. This allowed segmentation of each lesson with deliberate inclusion of planned discussions, group activities, group reporting, breaks and debriefs. Similarly, syllabi, which were provided to students, listed the instructor's contact information, workshop objectives, student learning outcomes, methods for instruction, required texts or materials and online classroom expectations. The materials list for each of the three-weekend workshops included the products, costs and corresponding web links at which the items could be purchased by families and shipped directly to them. A template for the materials lists can be found in Appendix C. The average cost for materials, including tax and shipping fees, for each weekend workshop, was $25. Upon submission of receipts, families received reimbursements via a Visa electronic gift card from the Institute.

PROGRAM STRUCTURE

Fridays: Online STEM Guest Presentation and Interactive Activities. As the opening day of each weekend workshop of the ALA program, Friday evenings were structured to introduce student participants to STEM and initiate peer engagement. Each Friday, the three-hour schedule, with intermittent breaks, encompassed a welcome, a STEM guest presentation and activities with the participants.

To orient students to the program on the very first Friday, parents and students were welcomed with an online orientation. Following the orientation, students were asked to complete a pre-program survey to gauge their STEM knowledge and skills prior to participation in the full program.

After the welcome, a STEM guest presentation was traditionally executed by a Ph.D. candidate or postdoctoral fellow from an underrepresented background in STEM to expose students to their area of expertise. Presenters frankly discussed their academic and professional journey, obstacles they may have encountered and how they overcame adversity. They also provided advice and a question-and-answer segment for participants who were in the midst of carrying out their own STEM journeys. One presenter from the National Cancer Institute's Cancer Prevention Program, shared her experience in the field as well as insight for students on navigating a career in STEM from high school through graduate school. The online guest presentations allowed students to see that a successful career in STEM is possible for someone with a similar background as them. It also gave them the tools needed to approach forging their own pathways.

Other presentations offered to student participants included a group of twelve minority scientists and industry professionals from a global biopharmaceutical company. They conducted a comprehensive presentation complete with a virtual tour of their laboratories, discussion on STEM opportunities in drug development and presentations on their ongoing research. Students participated in rotating breakout groups with the presenters to discuss the drug development process, clinical trials, technology intervention practices, trademarks as well as marketing strategies utilized in the field. In each breakout group, students were able to pose specific questions to each presenter to learn more about each topic and the presenters. While providing the participants with knowledge surrounding the utilization of STEM in a corporate setting, students also learned about research opportunities and the different departments involved in creating and providing medicines to patients.

The Friday evening STEM activities, which were conducted by two youth educators, were designed to facilitate bonding among the student participants. Breakout groups were composed of both new and returning students from all four ALA STEM tracks to encourage intermingling and sharing of interests. The activities included icebreaker games, such as STEM Taboo, a word game where a student had to describe a STEM-related word on their card to their group without stating four related words that were also listed on their card. Other activities included a virtual escape room; where students collaborated to solve scientific puzzles, brain teasers and logic problems to obtain codes to escape descriptive scenarios. Returning students in each group assumed leadership roles by keeping their cameras on and helping to start introductions, conversations as well as the activities, which increased the comfort level of group mates and fostered more meaningful interactions. All icebreakers and activities allowed students to meet, collaborate and engage with like-minded peers from different ALA STEM tracks in interactive purposeful ways.

Saturday: Online STEM Workshops. On Saturdays, the workshops operated for six consecutive hours, including two 20-minute breaks and a 60-minute break for lunch. Faculty instructors could also implement additional breaks to lessen

screen fatigue. Table B1 displays the Saturday and Sunday schedules. Accordingly, the Saturday and Sunday workshops that were conducted by the faculty in each track during the program can be found in Table B2. The Saturday workshops entailed a mixture of lectures, group discussions, breakout groups, readings, case-studies, utilization of web-based software and collaborative exercises, including design challenges and hands-on activities. By using a variety of teaching methods in an online setting, the interest levels of students were reignited throughout the workshop to promote continual engagement and practical application of the knowledge obtained during the lessons.

For example, during a Biomedical Engineering and Technology track workshop, students delved into electricity and the brain's neurological network by first learning about different parts of the brain and the nervous system via lectures and discussions. An activity that followed included a design challenge tasking students to create a protective helmet for the brain out of everyday materials obtained via the previously shared materials list. These materials included cardboard, a foam hollow sphere, tape, glue and ribbons, as well as other items they may have had at home. After learning about the constructive aspects of a helmet through lecture and group discussions, students selected a type of helmet (i.e. ski, construction, bicycle helmet etc.) and worked in breakout groups to discuss their designs to ensure they met specific requirements, such as full head coverage, chin strap and protective eye covering. Students adhered to the engineering design process by constructing their own individual helmets, testing their construction, pinpointing problems and making modifications for improvement. Then they worked together to create a 3-5 minute Google Slides presentation showcasing the helmets in their group, including introductions of the group members, pictures of the helmets, testing videos and details of the design requirements that may or may not have been met. After learning about the brain and its network via different teaching methods, the hands-on materials provided practical application of the lesson.

In contrast to the hands-on materials utilized in the Biomedical Engineering and Technology Track, the Artificial Intelligence and Technology track, primarily utilized freely accessible and collaborative web-based software to incorporate interactivity into the workshops. This has been shown to help instructors and students view each other's work, prioritize engagement, as well as limit technical difficulties related to different computer operating systems (Cook-Chennault et. al, 2021). When delving into the world of game development, emphasis was first placed on personal storytelling and narratives that could be incorporated in engaging parts of a game because as individuals from varying backgrounds and experiences, the inclusion of these elements was important. Students began by learning programming concepts in C# using Repl.it, an editor and interpreter, to compose programs and collaboratively practice debugging. In successive workshops, Unity, the game development environment, was explored. Students developed animated characters and the surrounding world as well as a multi-level game that emphasized their game's narrative.

To enhance workshop curriculum, faculty instructors oftentimes invited outside guest presenters from underrepresented backgrounds in STEM, to briefly speak to students in their track. Some guest presenters in the Artificial Intelligence and Technology Track included game developers, game creators and artistic game designers to enlighten students on their professional pathways and inspire them to pursue careers in the industry. Similarly, guest presenters in the Biomedical Engineering and Technology Track included a scientific director of research and development who discussed drug development in relation to COVID-19, and a neurodegeneration researcher who addressed diseases that are associated with aging.

Sunday: Online "New Thinking" Workshops. On Sundays, the "New Thinking" workshops operated for three consecutive hours with two scheduled 10-minute breaks and any additional breaks instituted by the faculty to prevent screen fatigue. Table B1 shows this schedule. The Sunday workshops added to the lessons taught in each track on the previous day. They aimed to cultivate novel ways of processing information by engaging students in exercises that compelled them to utilize both critical thinking and creative thinking skills in problem-solving challenges. The "New Thinking" workshops allowed students to collaborate, innovate and explore plans of action to address major concerns through their specialized track of STEM study. Table B2 displays the workshops offered in each track.

Encouraging minority students to become more knowledgeable and engaged in STEM by using relevant topics on community issues and teaching them how to be socially responsible STEM professionals has been an important element of the curriculum in the ALA STEM Tracks as attested to in the literature (Cummings et.al, 2021). In the Medical Science Track, students explored the cell biology of aging during one Sunday "New Thinking" workshop. This followed the previous days' lesson on the cell biology of cancers by connecting cellular dysfunction to cancer and aging and showcasing the molecular and genetic roots of these issues. At the beginning of the "New Thinking" workshop, students gave 10-minute group presentations on a specific form of cancer that was assigned to them for homework, permitting students a chance to cooperate and conduct research based on the knowledge they attained. A lesson then ensued addressing how cellular changes could trigger the beginning of aging. Emphasis was placed on non-genetic factors that could lead to aging and potential disparities along racial and ethnic lines that are expressed as differences in the lifespans

for disparate groups. This workshop was meant not only to enhance students' knowledge but to also encourage them to utilize that STEM knowledge for the benefit of others. Therefore, as future medical professionals, it was important to help students understand the health disparities that exist among people from different demographics.

In one of the "New Thinking" workshops of the Applied Mathematics track, the worldwide issue of solar energy harvesting was addressed. Utilizing research talks, videos, and discussions on solar energy conversion as supplementary material, students used statistical modeling to analyze fossil fuel consumption data to predict the energy outlook of the world. To combat this issue, students worked in groups to research other avenues of solar energy conversion, including electrical energy, chemical energy, and solar fuel; they presented their findings to their peers. By exposing students to the application of statistical modeling, they were encouraged to critically ponder larger global issues and take steps towards effective long-term solutions. Overall, each ALA track covered related topics on Saturdays and Sundays that allowed students to delve into specific topics in their track and enhance their knowledge and skills in the field over time.

EVALUATION

Surveys. Anonymous surveys were utilized in the ALA to gauge students' experience and the effectiveness of the program. In doing so, honest feedback from participants on each aspect of the program was obtained, and participants' awareness levels of specific STEM information was gauged in aggregate. Specifically, two sets of anonymous surveys were distributed to program participants. One set was given to participants pre and post partaking in all three-weekend workshops of the program. The second set was administered to participants after the Sunday "New Thinking" workshops, at the end of each weekend workshop.

Pre-Program Survey and Post-Program Survey. Prior to the start of the 2021 ALA online program, students (N=88) anonymously completed a digital survey. The survey assessed students' awareness of specific STEM content using a Likert scale ranging from 0, representing "Not Very Aware," to 10, representing "Very Aware." At the conclusion of the program, students (N=76) completed the same survey evaluation, which permitted pre- and post-program comparisons. The quantitative data from both surveys were analyzed.

A juxtaposition of students' awareness levels in STEM-specific content were compared prior to participation and following participation in the 2021 online ALA program. This can be seen in Figure A1. The data shows an increase in awareness among students for careers related to the ALA STEM tracks in which they participated. Additionally, the comparison results show that students experienced an increase in awareness of specific subject information related to the ALA STEM track in which they participated.

Post-Weekend Workshop Surveys. In addition to the anonymous survey that was distributed to students before and after the ALA program, an anonymous survey was disseminated to participants at the end of each of the three-weekend workshops that occurred in January, February, and April 2021. Using a mixed methods approach, this permitted both new and returning participants who completed the surveys, to provide quantitative and qualitative feedback on each aspect of the program, including the Friday STEM guest presentations, the Saturday and Sunday STEM workshops, and other program components in the online environment. It also allowed program facilitators to make modifications after each weekend workshop that were aimed to better meet students' STEM needs. Table B3 shows the allotment of participants who completed the three surveys in relation to their standing as new or returning students.

These surveys utilized a Likert scale ranging from 0, representing "No value at all," to 10, representing, "Highest value." The mean score was then calculated for each section of the surveys. Using quantitative data collected from corresponding sections of the three distributed weekend workshop surveys, an overall mean score was calculated per section for both new students and returning students. Students also provided written explanations to qualify their ratings. Data for both student groups were separately analyzed to mitigate the inclusion of bias from returning students who would already harbor positive attitudes about the program due to previous participation. By analyzing both information from new students and returning students, the program's effectiveness was analyzed from the lens of new students while longevity of impact was assessed among returning students.

Qualitative feedback from the open-response questions was also analyzed through a thematic analysis framework to provide specific information and insight relative to the quantitative data. New and returning students' responses for the Friday STEM guest presentations and the Saturday and Sunday workshops from all three surveys were analyzed via thematic coding. Emerging themes revealed common engaging components and recommendations. In doing so, a robust representation of participants' perceptions was provided to further assess the effectiveness of the online ALA program.

Finally, the third post-weekend workshop survey that was distributed after the last weekend workshop was used not only to evaluate students' perceptions of the Friday STEM guest presentation and the Saturday and Sunday workshops, but it was also employed to analyze program components in the online environment. In addition to the same 10-item Likert scale that was utilized, a five-point scale, featuring "strongly agree," "agree," "disagree," "strongly disagree,"

and "not applicable," was used to gauge students' level of agreement to listed statements.

RESULTS

Friday STEM Guest Presentations. The mean score for the online STEM guest presentation, conducted during the first Friday workshop by the scientist from the National Cancer Institute's Cancer Prevention Program, was rated 8.55/10 (SD = 1.67) among new students (N=70), and 8.53/10 (SD = 1.87) among returning students (N=20). Furthermore, the mean score for the STEM guest presentation provided by the twelve biopharmaceutical scientists and industry professionals during the third Friday workshop was rated 8.53/10 (SD = 1.69) by new students (N=64). Given returning students had already experienced this presentation during a previous year of participation in the ALA program, returning students participated in a different career development STEM activity. Resultantly, for this specific STEM guest presentation, quantitative and qualitative data among returning students was not included.

A thematic analysis of existing qualitative data revealed four themes showcasing components of the two online STEM guest presentations that engaged students. These themes included presenters who shared: tools for future success, specific details about their STEM fields, personal background information relative to their professional journey, and considerate answers to student-posed questions.

The majority of students' responses (46%) showed that online STEM guest presentations that offered tools to help them prepare for future success were highly valued. Two subthemes that emerged included: (a) tools for collegiate success, and (b) tools for professional success. Students commented:

> "*She gave us so much useful information that I will remember when applying to different colleges. I loved that everything was specific for those with an interest in STEM.*" (Biomedical Engineering and Technology Track, New Student)

> "*She made me more interested into looking into scholarships that are available.*" (Biomedical Engineering and Technology Track, Returning Student)

> "*I really found it important to listen to and talk about. The topics within the lesson will be very important going forward and can be applied to college and job applications.*" (Medical Science Track, Returning Student)

> "*This guest presentation really helped on preparing me for my future and getting my name out there. It also showed me the multiple resources I could use and the pro-tips that would help me prosper.*" (Artificial Intelligence and Technology Track, New Student)

Furthermore, students' responses (27%) indicated that they favored the opportunity to learn more details about the presenters' specific STEM fields. Two subthemes were expressed. Students enjoyed learning about (a) industry-specific STEM information, and (b) the application of this information to relevant STEM issues in society. Students shared:

> "*I'm very interested in biochemistry and everybody always says there are a lot of good applications for that in the pharmaceutical industry, which sounded a little boring to me but getting an insight into the process of developing and marketing a drug was very eye-opening for me and helped me realize that if I wanted to go that way in life I wouldn't have to compromise the things I'm really interested in.*" (Applied Mathematics Track, New Student)

> "*I found it very interesting to learn how medical experiments were conducted. This was especially interesting during the time of a pandemic.*" (Applied Mathematics Track, New Student)

In addition, students' responses (12%) showed that learning about the presenter's background in relation to their professional journey made the online guest presentation more intriguing. Students noted how inspiring it was to hear the presenters' journeys and the fuel it provided for achievement of their goals.

Finally, students' responses (15%) revealed that they found it engaging when presenters thoughtfully answered student-posed questions.

> "*I loved the guest speaker. They put a lot of work into the presentation and answered the questions very well.*" (Biomedical Engineering and Technology Track, Returning Student)

> "*I really enjoyed the session and having the opportunity to ask questions to professionals who were POC in various fields of STEM at a major company.*" (Medical Science Track, New Student)

Overall, STEM guest presentations that included advice for success, in depth STEM information, presenters' personal stories as well as a thorough question and answer segment were perceived as valuable among both new and returning student participants in the online ALA program. Future presentations in online programs that include these elements may achieve similar results.

Saturday STEM Workshops and Sunday "New Thinking" Workshops. The overall mean score for the online Saturday

workshops and the Sunday "New Thinking" workshops in each ALA STEM track can be seen in Figure A2, indicating that both new and returning students highly valued the workshops' content and the information learned from the faculty instructors. In addition to analyzing the quantitative data, a thematic analysis of students' qualitative data was conducted for the Saturday workshops and Sunday "New Thinking" workshops to evaluate the online workshops' engaging features along with students' recommendations for workshop enhancement.

Engaging Features of the Online Workshops. After providing quantitative ratings regarding the Saturday and Sunday workshops, students were permitted to provide comments elaborating on their experience. Feedback from student participants revealed three themes that contributed to engaging aspects of the online workshops: collaborative activities, opportunities to learn new STEM information and its applications, and interactive instructors.

The majority of students' responses (49%) highlighted collaborative activities as engaging parts of the online workshops. Three subthemes were expressed by students: (a) group discussions, (b) hands-on activities, and (c) computer-related activities. Group discussions permitted students to explore STEM topics while presenting their own information and hearing other students' viewpoints in a welcoming environment. Students stated:

> "*Overall, this session was amazing. It was a great way to think from a different perspective and come up with multiple solutions. It was very interactive. It was very good to hear the students' opinion on the topic.*" (Applied Mathematics Track, New Student)

> "*We had a good discussion in how socioeconomic status and race plays a part in healthcare and life expectancy that was enlightening.*" (Medical Science Track, New Student)

> "*I really enjoyed presenting about my particular cancer as well as hearing about different kinds of cancers from the other students. I think connecting the ideas that were learned yesterday via a project really helped to hone in on the concepts.*" (Medical Science Track, Returning Student)

Additionally, hands-on activities, which utilized physical materials that were shipped to students' homes, granted them an opportunity to both learn and display their learning in a challenging yet imaginative manner with their peers. Similarly, given the online nature of the program, computer-related activities were viewed as opportunities for engagement and application of the STEM curriculum. Students stated:

> "*I loved that these workshops provided a lot of background information that we were then able to use to create designs of our own; it was a good mix of lectures and hands-on activities.*" (Biomedical Engineering and Technology Track, New Student)

> "*I really enjoyed the group activity we had, and the information of the monomyth was something I was familiar with, but I had never used it in this game context.*" (Artificial Intelligence and Technology Track, New Student)

> "*It was very cool to see how games are made and working in the groups to make a game was very fun.*" (Artificial Intelligence and Technology Track, New Student)

Furthermore, students' shared responses (37%) indicating that engagement was achieved in the Saturday and Sunday online workshops when they were afforded opportunities to learn new STEM information and its applications.

> "*I thought both sessions were extremely informational and helped me expand my knowledge on topics I knew basic things about!*" (Medical Science Track, New Student)

> "*I love how we explored different types of tests such as RFLP, SSCP, etc. I liked the connections we made to real-word espionage in the business and biotechnology realm.*" (Medical Science Track, Returning Student)

Lastly, students' feedback (14%) indicated that the interactive faculty instructors made the workshops more engaging. Qualities of interactive instructors in each STEM track included those who were "kind," "positive," "welcoming" and "encouraging," for it made the workshops more "enjoyable and lively." Instructors who also exhibited "patience" and "helpfulness" when working with students through online challenges were applauded. Students also appreciated instructors who intermittently checked on them while they were in breakout groups. Moreover, knowledgeable instructors who provided "clear explanations" that also cultivated "critical thinking and questioning" were valued because it helped students become more invested in the workshop topics.

In conclusion, collaborative activities, opportunities to discover new STEM information and its applications as well as interactive instructors were identified by new and returning students as three themes that impact the engaging aspects of online workshops. Given these components resonated well with students, integration of these elements could be included in other online programs.

Recommendations for Online Workshop Enhancement. In addition to providing feedback on their experience in the

Saturday and Sunday workshops, participants then offered recommendations to improve the workshops. While most feedback (80%) listed no recommendations, feedback from remaining participants unveiled three themes that highlighted recommendations for workshop enhancement. These themes included a desire for more interactive activities, more in depth examination of specific STEM content, and technological improvements.

While the STEM workshops incorporated varied teaching methods and activities, students' responses (11%) requested more interactive activities to further digest and apply the information they learned. Students shared:

> "*Maybe having two activities, so building/ prototyping two things.*" (Biomedical Engineering and Technology Track, New Student)

> "*Try to make them more physically active, rather than maybe doing a simulation on the computer.*" (Applied Mathematics Track, New Student)

> "*No recommendations except maybe a few more interactive activities to review ex. a kahoot, quizlet, or quizziz after lunch to review the morning session.*" (Medical Science, New Student)

After gaining knowledge and skills from the curriculum that was presented in the STEM tracks, participant feedback (7%) expressed a desire for more in depth examination of specific STEM content during the workshops. Students commented:

> "*I would love to delve more into drawing proteins/ connecting polypeptides, diagnosing, finding treatments and preventions, and understanding genomic sequences better and where there would be mutations and where they look just fine.*" (Medical Science Track, Returning Student)

> "*More AI, but these workshops are amazing! I am learning a lot everyday.*" (Artificial Intelligence and Technology Track, Returning Student)

> "*I kind of wanted to work a bit more with standard deviation instead of just hearing about it. It's a strange analytical tool, and I would have wanted to explore how to operate it with an expert.*" (Applied Mathematics, New Student)

In addition, students' feedback (2%) recommended technological improvements to the online nature of the workshops. Students mentioned desiring instructors to screen share when explaining online software for more visual explanations. Utilization of closed captions on YouTube videos and Zoom presentations were requested to help those who sometimes encounter volume issues or audio distortion. Furthermore, although freely accessible web programs were utilized, such as Google Colab, some students using a school-issued Chromebook experienced permission issues and could not access the program. While a workaround was used by having students create Gmail accounts to access the program, valuable teaching time was used to generate this fix.

In summary, recommendations to improve these online workshops include providing more interactive activities, a deeper investigation into specific STEM content, and technological improvements. Improving upon these features may engage a greater number of workshop participants in the online STEM environment and abate technical issues that may arise.

Online Environment and Policies. Additional questions were listed at the end of the final weekend workshop survey (N=76) to gauge students' experience participating in an online environment as well as the program policies that were created to accommodate the workshops in this setting. Using the same Likert scale ranging from 0, representing "No value at all," to 10, representing, "Highest value," new students (N=64) and returning students (N=12) on average rated their overall experience in the three online weekend workshops 9.14/10 (SD = 1.05) and 8.83/10 (SD = 1.99), respectively. This emphasized the quality and effectiveness of the 2021 Accelerated Learning Academy (ALA) STEM program in an online environment. Furthermore, in regards to utilization of the Zoom platform during the program, new students and returning students provided ratings of 8.45/10 (SD = 1.69) and 8.83/10 (SD = 1.75), respectively.

Furthermore, when gauging student perspectives regarding the workshop lengths, breaks, the materials list and the reimbursement policy on this survey, students were presented with a group of statements and asked to select their level of agreement based on a five-item scale, including strongly agree, agree, disagree, strongly disagree and not applicable. When asked if the length of the online workshops during the weekend workshops was manageable, participants "strongly agreed" (36%) and "agreed" (59%); whereas, 5% of students "disagreed." Similarly, when asked if the time allocated for breaks during the weekend workshop was appropriate, participants "strongly agreed" (48%) and "agreed" (48%); whereas, 3% of students "disagreed" and "strongly disagreed" (1%). Although the majority of students were comfortable with the length of the workshops and breaks, more consistent encouragement of faculty instructors to initiate additional unscheduled breaks to accommodate fatigued students can be implemented. Furthermore, students "strongly agreed" (56%) and "agreed" (29%) that the personal procurement of self-purchased materials for the workshops was manageable; 15% of students indicated "not applicable" perhaps because they were not required to purchase items for the workshops. The materials list, complete with prod-

uct descriptions, quantity, price and direct web links for purchasing in addition to the average maximum cost of $25 per weekend workshop, was well received by student participants. Moreover, students "strongly agreed" (44%) and "agreed" (29%) that the reimbursement policy/process for materials during the weekend workshops was appropriate; whereas, 27% of students indicated "not applicable," which may indicate that they did not have to purchase materials or would not be submitting receipts for reimbursement. The majority of students who purchased items were comfortable with the policy advising families to submit receipts after each weekend workshop to ultimately receive reimbursement via a Visa electronic gift card. This method is an alternative to shipping materials directly to families, which can be helpful for organizations with limited resources wishing to offer hands-on experiences to motivated students in home settings.

DISCUSSION

Conditions caused by the COVID-19 pandemic have challenged co-curricular programs across the nation to seek modifications to provide youth with continued STEM education. When charged with creating an engaging interactive STEM program in an online setting for high-achieving high school-aged students of color, the Accelerated Learning Academy offered online programming in Applied Mathematics, Artificial Intelligence and Technology, Biomedical Engineering and Technology and Medical Science. Although the program occurred online as opposed to in-person, overall, both new and returning participants derived gratification from the guest presentations, workshops, and activities, which was helpful for expanding their knowledge, skills and interest in pursuing careers in STEM fields.

Attributes of this program can be applied to other programs seeking to offer engaging online STEM workshops to students via distance learning. The recruitment of guest presenters, faculty instructors, and even students from diverse backgrounds across the country to virtually participate can foster more inspiring conversations and an exchange of ideas. Guest presenters can engage students in the online environment by providing detailed STEM information, background information in relation to their professional journey, advice for students' academic and professional success as well as thoughtful answers to students' questions. Similarly, knowledgeable instructors who cultivate a welcoming and lively online learning environment while positively interacting with students and offering new STEM content that promotes critical thinking can keep students invested in workshops over time. The standardization and segmentation of lesson plans to intentionally include breaks and interactive elements can provide the foundation for ensuring the workshops are engaging for students in an online setting. The inclusion of diverse teaching methods, such as lectures, group discussions, freely accessible web-based software and hands-on activities can keep students engaged and while providing practical application of the knowledge and skills obtained from the lessons. These interactive activities can be made possible by instituting a materials list and reimbursement policy for the personal procurement of items for at-home experiments. Altogether, these workshop elements can positively impact students' STEM interests and preparedness to pursue an associated career in the future.

Challenges that the ALA program experienced can be addressed in future online programs or research. Some student participants expressed a desire to participate in more interactive activities and a deeper examination of specific STEM content. While this could be accomplished with longer workshops or additional weekend workshops, more research is needed to ensure student engagement can still be achieved in an online setting. Furthermore, while the usage of school-issued Chromebooks gave some students needed computer access, permission issues limited sign-in capabilities to some freely accessible software. To limit troubleshooting during the workshops, providing pre-workshop software instructions to students can allow them to test their computer's capabilities ahead of time and permit instructors to pivot software requirements if necessary. Given Chromebook allocation has been a significant aid, especially to students of color and students in low socioeconomic communities during the pandemic, exploring more ways to accommodate this technological resource in co-curricular online programs is paramount (Fishbane and Timer, 2020). Finally, in light of the online ALA program's focus on high school students in this paper, more research on the effectiveness of online STEM programs for an even younger demographic, such as middle school and elementary school youth, should be researched in the future.

LIMITATIONS

There are a few limitations that should be noted for this paper. The data derived from the surveys that were distributed to students are based on self-reports, which may be influenced by individual biases, and thus, lack objectivity. While anonymous surveys were used not only to obtain comprehensive and candid feedback from participants on each aspect of the program, but also to gauge students' awareness levels of specific STEM information in aggregate, future programmatic studies can consider using confidential surveys to track students' individual responses and awareness levels over time. Additionally, although 95 students participated in the program, a 100% response rate was not reached for each survey. However, given the majority of students completed each survey, the presented results still reflected students' honest overall perception of the program. In fu-

ture analyses of this program, the aim will be to ensure full survey completion by student participants, and thus, report larger sample sizes.

CONCLUSION

There is a need to expand the pool of talented science, technology, engineering and mathematics professionals who come from underrepresented backgrounds. The 2021 Accelerated Learning Academy is an example of an effectively operated online STEM program for this demographic. For programs seeking to engage minority high school youth in STEM, a virtual program should be given thoughtful consideration. In an effort to lessen the disparities that exist in STEM careers among underrepresented groups, it is important for co-curricular programs and other educational institutions to continue adjusting to unanticipated circumstances and providing quality programs for youth to keep them engaged in the STEM pipeline.

ASSOCIATED CONTENT

Supplemental material mentioned in this manuscript can be found uploaded to the same webpage as this manuscript.

AUTHOR INFORMATION

Corresponding Author

Crystal Watson, W.E.B. Du Bois Scholars Institute, Princeton, NJ. E-mail: crystalchwatson@gmail.com; admissions@duboisscholars.org

Author Contributions

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ABBREVIATIONS

AI: Artificial Intelligence; ALA: Accelerated Learning Academy; STEM: Science, Technology, Engineering and Mathematics

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