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THE BELL STEM & ROBOTICS SUMMER 2022 WORKSHOPS FINAL REPORT

WHO WE ARE

Books Education Learning & Life (BELL Organization) was founded with the goal of providing educational opportunities for all youth, young adults regardless of socioeconomic status. Bell Organization is made up of passionate professionals in STEM fields as well as non-related STEM fields. In partnership with former and current elected officials, our mission is to devise and implement quality STEM/STEAM programs and mentorship opportunities for youth and young adults from disadvantaged communities.

Underrepresentation in STEM/STEAM fields

According to the United States Bureau of Labor Statistics (BLS), in 2018, 7.31 million Americans employed STEM careers, an increase of 7.48% over 2016, when there were 6.80 million STEM workers. BLS expects an uptick in most STEM occupations over the next decade, which may provide additional opportunities for people interested in entering this growing field. By 2028, the BLS predicts 8.05 million STEM workers.

Black and Hispanic workers remain underrepresented in STEM fields. Blacks represent 11% of the U.S. workforce overall, but only 9% of STEM workers. Hispanics represent 16% of the U.S. workforce, but only 7% of STEM workers. The underrepresentation in the STEM field has a number of possible causes, but a significant factor may be that blacks and Hispanics lack access to quality educational opportunities that prepare them for these fields and are not encouraged at an early age to pursue STEM-related careers such as engineering, computer programming and mathematics.

With those dismal numbers displaying the lack of representation of minorities in the STEM fields. We would like to champion the change by helping to cultivate youths of low socio-economic backgrounds the chance at early opportunity to learn and envision STEM.

BELL STEM & Robotics Workshop

BELL Organization’s STEM and Robotics Workshop was hosted in the community center of Tracey Tower in the Bronx located on 40 W Mosholu Pkwy S, Bronx, NY 10468 which involved middle school and high school students building and programming robots utilizing a complete robotics engineering system. The reason for our organization hosting the workshop in that zip code was because its public high school graduation rates are less than New York. As robots and AI have grown exponentially and opened up a new era in industry, math is providing critical thinking and problem-solving skills that can prove valuable in life.

Figure 1:Tracy Towers in the Bronx

Zip Code 10468 has an extremely large population density, with most of the residents in the area being minorities. Black Or African Americans make 25.9%, American Indian or Alaskan Native 1.7%, Asian 4.7%, Native Hawaiian & Other Pacific Islander 0.1%, Other Race 36.1%, Two Or More Races 6.8%. The white population in the zip code stands at 24.8%. 53% of the residents in the zip code are females. There are also an extremely large number of single parents and an extremely small number of families. When it comes to income, men in zip code 10468 earn an average of $26,249/year while women earn only $22,965 per year.

Our STEM Math & Robotics Workshop was split into two components, the math component was taught by Ms. Julinda Pillati Mujo, a PhD Candidate at the CUNY Graduate Center and an Adjunct Lecturer of Mathematics and Physics at Lehman College and Hunter College, and the robotics component was led by Mr. Grant Kachenjera, a Computer Science graduate. Ms. Jessica Munoz, a computer science student at Hunter College who is also an intern at Google, was the assistant instructor for both the mathematics and robotics sessions.

The workshop ran on weekends from June 4th, 2022, to June 18th 2022. By implementing these workshops, the objective is to stimulate interest, build up a support system between parent and student in order to pursue STEM, and build morale.

Figure 2: A poster flier that was used to advertise the program in the community and on social media.

We summarize the general purpose of the workshop:

- Motivate community interest in STEM and the pursuit of STEM-related careers.
- Utilizing the National Science Standards to help students improve their understanding of science
- Build morale via a support system between parent and child.

A total of 28 students applied for the workshop and out of the total applicants, 17 were admitted into the program. From the 17 participants, 8 students were in 7th Grade, 3 students in 8th Grade, 3 students in 9th Grade, 2 students in 10th Grade, and 1 student in 12th Grade. The chart below shows the enrollment distribution of students' grade levels into the program.

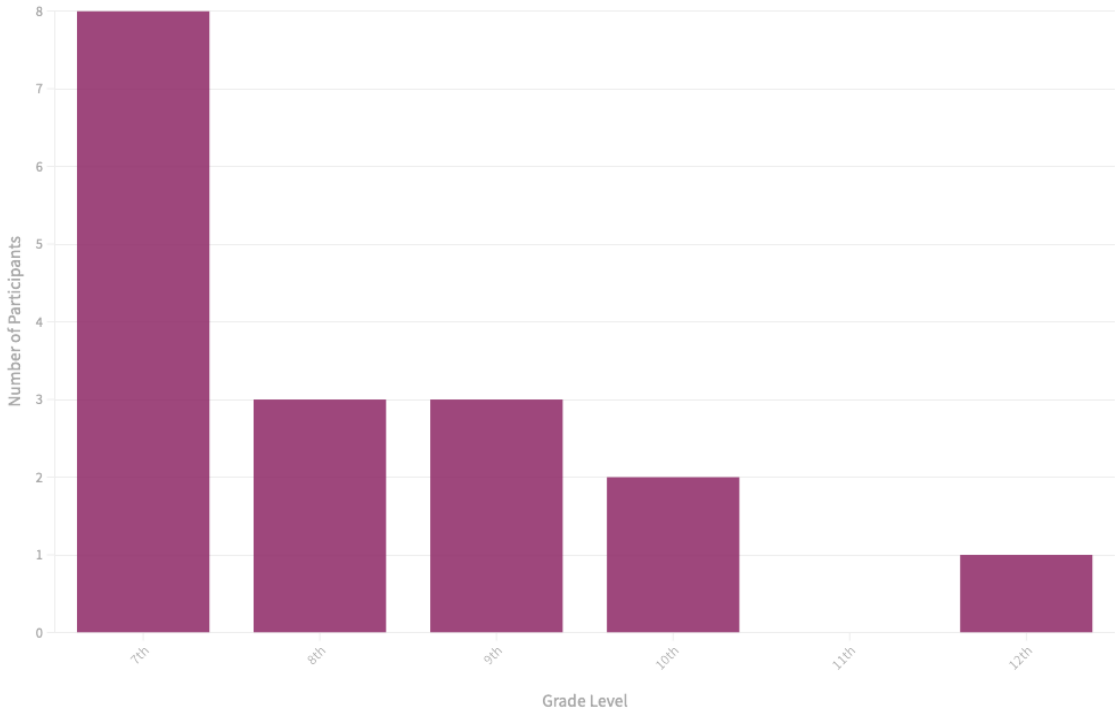

Figure 3: Showing the school grade level of the participants

We had other students who were accepted into the program but did not attend. Also, some parents had to withdraw their students just before the start of the program due to prior engagement or scheduling conflicts.

We required the students in the program to be ten years or older. So, for the participants in the program, the ages varied between 11 and 15.

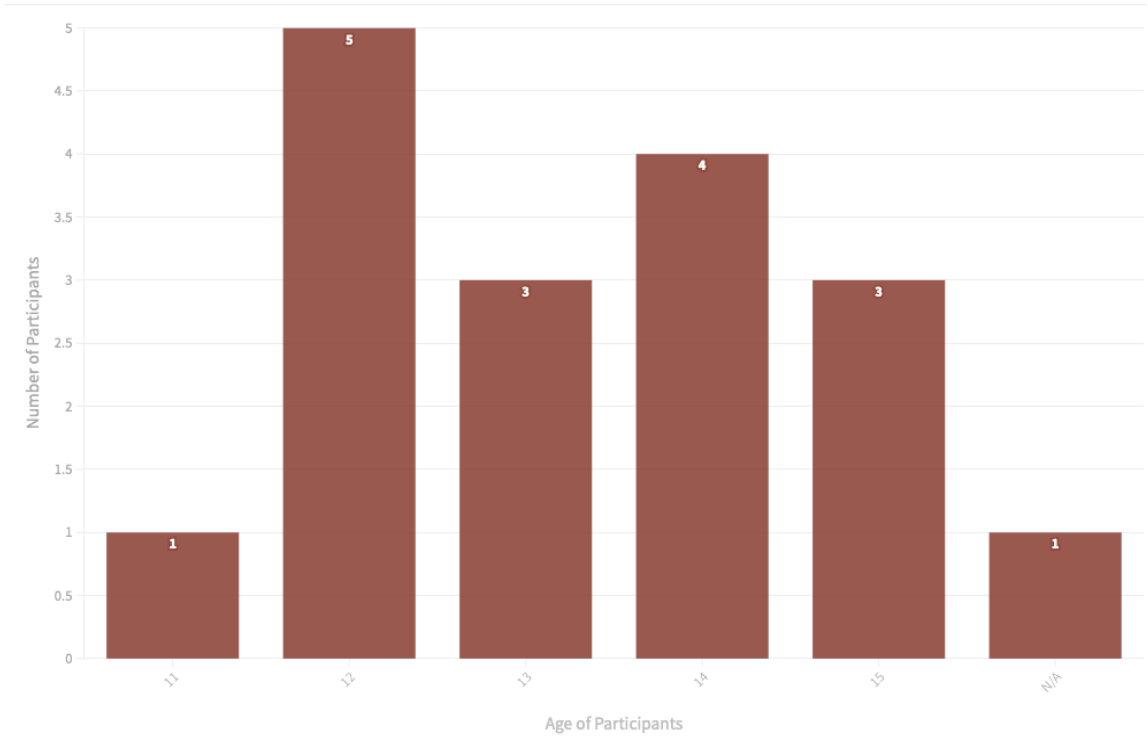

Figure 4: showing the age ranges of the participants

Out of total participants, 6 were female and 11 were male. This means that the representation of females in the program was 35.3% (6/17) while the representation of males was 64.7% (11/17). In the future, we will make more efforts to increase the number of female applicants and admitted students in the program.

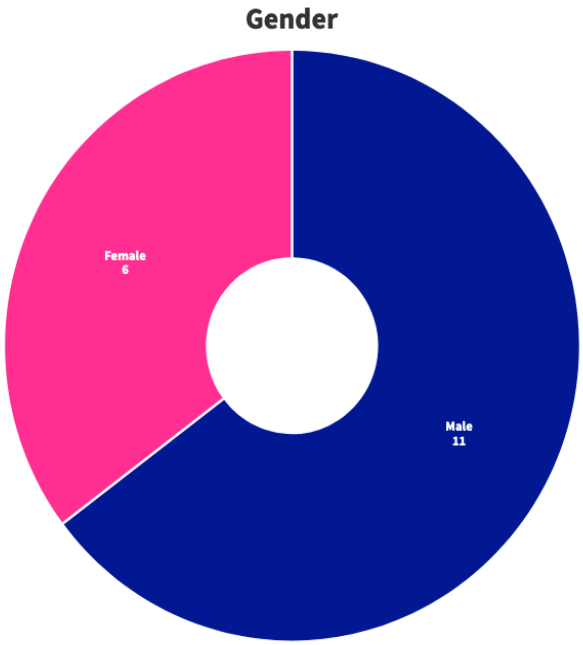

Figure 5: showing participants' representation by gender

The students came from different schools and parts of New York City. Most of the participants came from the Bronx, with one student coming from Queens. We had no students from Manhattan, Brooklyn, and Staten Island. We plan to increase our advertisement in these areas in the future.

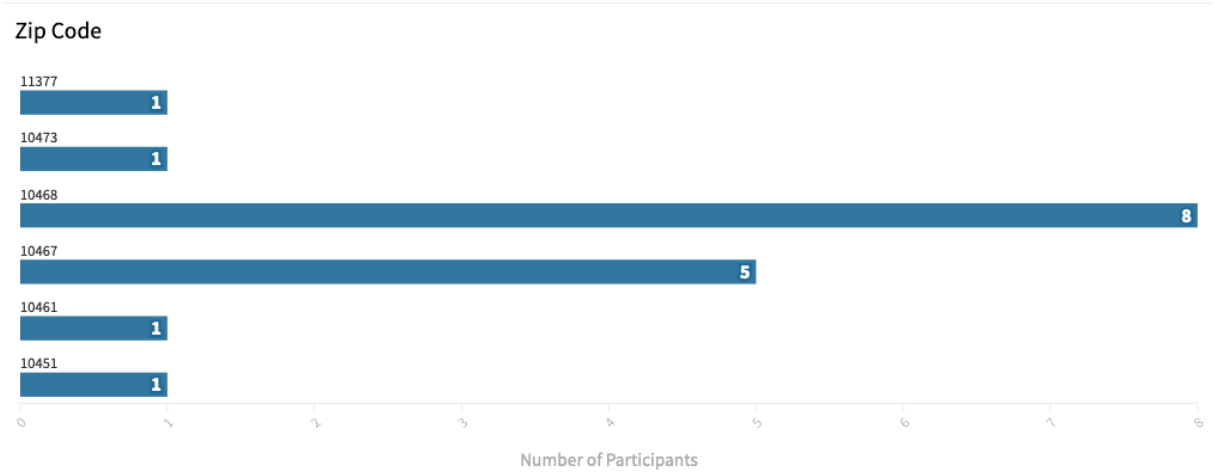

Figure 6: showing participants origin by zip code

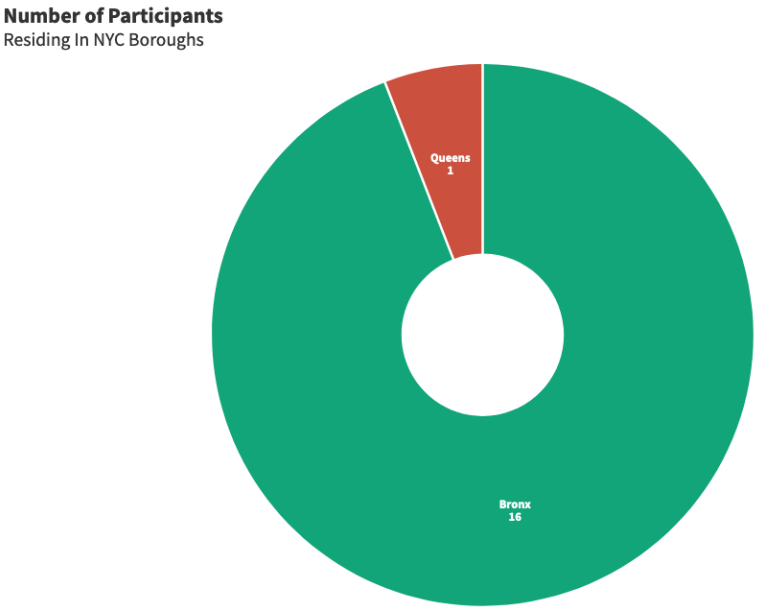

Figure 7: showing participants origin by Borough

Our workshop series was able to equip students with the tools and knowledge needed to design, build, and program robotics. The math began with fundamental math exposure, followed by instructions for building a robot and learning how sensors operate the robot.

Day 1: Math for Robotics - Problem Solving and Computation Thinking

On the first day of the workshop students were introduced to mathematical concepts and skills needed to build and program robots. Through a series of interactive lessons and hands-on activities, students learned about key mathematical concepts such as algebra, geometry, and trigonometry, and how they can be applied to the field of robotics.

The instructors focused on helping students develop a deep understanding of these concepts and how they can be used to control the movement and behavior of robots. And in the next following days of the workshop, students had the opportunity to work with a robot.

Figure 8: Engaged students attentively absorbing knowledge from their dedicated instructor on the first day of the workshop.

Day 2: Introduction to Robotics and Robot Building

The second day of the workshop focused on introducing students to the basics of robotics and building a robot. The students were given an overview of the history of robotics. Students were told that robots are machines controlled by computer programs. These machines can do many different things such as play soccer, vacuum floors, climb mountains, and cook dinner. The students were given a detailed explanation of the different types and components of a robot such as sensors, actuators, and controllers.

Next the instructors distributed robotics kits (parts) to students to start the process of building their own robot. Students were told that using these kits can build robots and program their motors, lights, and speakers to behave in different ways depending on the data coming from their sensors.

Next, students were then shown how to build a simple robot using a kit that was provided to them. Instructors were readily available to work with students struggling to put the robots together.

Figure 10: An excited student (center) posing for a picture upon receiving his robotics kit

Figure 9: Another excited student (center) posing for a picture upon receiving his robotics kit

Day 3: Robotics Programming and Final Presentations

On the third day of the workshop students focused on programming their robot. They were first given a brief introduction to programming and were shown how to program their robots to perform simple tasks such as moving and detecting an object. The students managed to program their robots to move and detect objects.

The workshop included an activity and challenge that tested participants' problem-solving and critical thinking skills as they were asked to reprogram their robot to navigate through a maze or pick up an object.

The last hour of day 3 of the workshop was dedicated to final presentations and awarding certificates of completion to the students. The students were given the opportunity to present their projects to their classmates, community leaders, BELL staff members, parents and guardians, and instructors. They were also given feedback on their projects and were encouraged to continue working on them. The showcases were followed by the award of certificates of completion to the participants.

Figure 11: Students, Instructors, BELL TEAM, Community Leaders, NY State Senator (formerly NY Assemblywoman) Nathalia Fernandez (first row, third from left) displaying Certificates of Completion for the BELL STEM & Robotics Summer 2022 Workshops.

Throughout the workshop, students were engaged and asked relevant questions pertaining to robotics, computer science, and mathematics. Students were also given the opportunity to collaborate with their peers. They were free to discuss their progress with their friends, observe their friends' progress, and share problems they encountered during the building and programming of the robot and how they solved them. This led to the improvement of interpersonal, communication, and problem-solving skills.

Expenditures

Item	Description	Cost
	Staffing	
Coordinator (1)	Responsible for helping oversee the successful completion of project and managing staff	$ 1,000.00
Instructor (1)	Develop & excutive program, curriculum, ensure program materials are engaging, assist in writing program report.	$ 2,000.00
Instructor Assistant (2)	Assist instructor during the workshop, helping students with questions.	$ 1,700.00
Data Collection Team (3)	Ensure data is collected, and verfied for reporting purposes	$ 1,700.00
	Equipment	
Supplies	PPE materials, Markers, Erasers, Printing Services.	$ 500.00
	Miscellaneous	
Catering	Food will be provided to particpating students	$ 100.00
Robotic Kits (10)	Kits needed for the students during the workshop.	$ 3,000.00

Pre-Workshop and Post-Workshop Tests

In the first session, students were given a pre-test to determine their level of knowledge with the subject matter. At the end of the workshop, we also gave students a post-test. We present what they shared in the following section.

Pre-Test

Before the instructors commenced the workshop, we asked participants to share with us their knowledge on math, science, and robots. Below we share what we learned from the pre-workshop tests.

Question	**Pre-Test Response**
I like science and math	4.6
I can build robots	2.3
I will consider going to college and becoming an engineer	3.6
I will study hard at math and science	4.8

Table 1: illustrates the responses to these questions for the pre-test. The questions were rated on a scale of 1 (strongly disagree) to 5 (strongly agree).

Responses to Additional Questions on the Pre-Test

In the pre-workshop test, we also asked students to describe in one sentence what they understood by the term 'robot'. The answers to this question varied but we were impressed with their responses. Below is what they shared to answer the question.

- A robot is a machine programmed to perform a series of instructions automatically or controllably with a remote device.
- A robot can be any machine that follows instructions or programs to complete a task.
- Technology
- A robot is a machine that replicates what a human can do but with maybe less effort and ease.
- A humanlike piece of machinery.

- Robots are machines that follow computer language to do simple/detailed/complicated tasks.
- A Mechanical Machine
- An electronic device capable of performing multiple tasks efficiently.
- Robotics is the engineering discipline dealing with the design, construction, and operation of robots.
- Metal and smart ones.
- A machine made by people to help.
- A machine that has at least some AI (to respond to commands)

We were also interested in understanding whether students knew where robots are used. As usual, below is what they shared:

- You can use robots to perform automated tasks like machines in a factory. Robots can also be used to help humans do something more efficiently.
- Robots can be used in many different places, such as hospitals, factories, and even where people live to help people get around their environment. Robots are very useful to people because they make tasks easier and more efficient. They can be used in the medical field to test for certain diseases and injuries.
- School
- You can use robots anywhere in your daily lives. Robots can also be used at work like at factories or at home to do basic chores like vacuuming.
- In factories, homes, workplaces, and schools.
- I can use robots in factories to do steps of making something or be used as a product to sell to other people.
- You can use robots in labs, hospitals, and police departments. You can use robots anywhere in your daily life.
- In factories. (Cars)
- In a healthcare
- We can use robots when we need help with a question.
- Everywhere.
- Robots can be used to complete many tasks such as collecting data, lifesaving treatment, everyday tasks and etc.

Post-Workshop Tests

At the end of the workshop, we also asked participants to share with us their knowledge on math, science and robots using a different set of questions.

Question	**Post-Test Response**
How many of the workshops did you attend?	2.6
After this workshop, are you more likely to attend another robotics workshop?	4.9
After this workshop are you more likely to want to try coding again?	4.7
After this workshop are you more likely to try building more robots?	4.6
Are you going to use your robot kit to build more robots?	4.3
After this workshop do you have an idea of what STEM is?	4.2
Do you want to pursue a career in STEM?	4.1
After this workshop do you consider pursuing a career in STEM?	4.3
Did you have difficulty with the material that was presented to you?	2.3
Did you find the robot you built challenging?	3.1
Did you find the coding challenging?	3.4
Did you feel like you had support for any of the questions you asked?	5.0

Table 2: illustrates the responses to these questions for the post-test. The questions were rated on a scale of 1 (strongly disagree) to 5 (strongly agree).

In this post-workshop survey, we also included two discussion questions for the students to share their understanding of STEM because of the knowledge they gain in the workshop and to share their opinions and feedback on this workshop.

Responses to Additional Questions on the Post-Test

The following was the first discussion question. What is STEM? Students provided the answers below.

- STEM is a company based on AI technology
- Science technology engineering and math
- Science, technology, engineering, and mathematics
- Science technology engineering mathematics
- Science, technology, engineering, and mathematics
- Science, technology, engineering, and mathematics
- Science, technology, engineering, and mathematics

We also asked students to provide us with any feedback in the post-test. Below is what some of the students wrote:

- Make more STEM classes
- I would like to build more robots :)

Pre-Test Analysis

The pre-test for the workshop was designed to assess the participants' prior knowledge and understanding of mathematics and robotics. We analyzed the results of the pre-test to determine the overall level of knowledge and understanding of the participants. Our analysis revealed that the majority of the participants had some basic understanding of STEM concepts, but there were some areas where they had limited knowledge.
For example, many of the students indicated that they liked mathematics. They also indicated that they study hard at math and science. On the other hand, very few students indicated that they knew how to build robots. This was a part that needed a major focus in our workshop.

Post-Test Analysis

We also analyzed post-test to assess what they gain from the workshop. The analysis revealed that most of the participants had a deeper understanding of STEM than they did before the workshop. In addition, most of the students indicated that they would consider pursuing careers in STEM. They also shared their plans to build more robots in the future at home. Finally, also of the participants felt that they had full support during the workshop. As an organization, we want to make sure that we support the community we work with.

The pre-test and post-test analysis showed that the workshop was successful at increasing the participants' knowledge and understanding of STEM particularly mathematics, robotics, and computer science. The results of the analysis were used to inform the design of future workshops and to ensure that the needs of the participants were met.

Conclusion

BELL STEM & Robotics Summer 2022 Workshop was a success, with a total of 17 participants in attendance. The workshop was designed to provide hands-on experience in building robots and using mathematical concepts to programming robots. Attendees were introduced to basic programming concepts, and then were guided through the process of programming a robot to perform various tasks. The workshop also included a section on the application of mathematical concepts such as geometry and trigonometry in robotics. The participants were able to successfully program their robots to complete a series of challenges and received positive feedback on the hands-on and interactive nature of the workshop.

Also, by providing a welcoming environment where students can express their opinions and make mistakes, it allowed the goal of students to improve their mathematics and computational skills. As a result of providing resourceful programs like ours, we can nourish and develop the youth from underprivileged communities and stimulate their interests into STEM careers by encouraging them to consider studying STEM subjects and potentially getting them out of an impoverished situation.

The workshops were led by experts in the field and provided a thorough introduction to the mathematical foundations of robotics and introduction to robotics.

For our post-test, we also learned communities need STEM workshops. We plan to run more of these workshops in the future so that we can be able to reach more people and help in building middle income communities.

Students appreciated the opportunity to work with robotics kits to build and program their own robots. Students were even more happy because they went home with a robot and books to use for their academic growth.