New York Academy of Sciences Innovation Challenge

Evaluation Report

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Introduction

This report presents findings of an evaluation of the New York Academy of Sciences (the Academy) Fall 2023 Junior Academy Innovation Challenge on cognitive classrooms, conducted by Education Development Center's (EDC) Center for Children and Technology. The evaluation used pre- and post-surveys to measure students' confidence with four areas of workforce-related skills: creative problem solving, communication, collaboration, and intercultural understanding. [See *Appendix A* for a full description of the evaluation's methods.]

Description of Challenge

The Academy's Innovation Challenges are designed to engage students ages 13–17 in experiential learning by providing opportunities for them to work in international teams that develop solutions to complex real-world problems. Teams collaborate through Launchpad, the Academy's online platform, and are supported by mentors to develop their solutions. NEOM[1]-sponsored challenges draw inspiration from both the spirit of innovation at NEOM and the cutting-edge scientific work that's happening within its region and industry sectors.

The Fall 2023 Innovation Challenge focused on cognitive classrooms—education environments that utilize collaborations between human knowledge and technological capability to create learning experiences designed to serve and adapt to students' changing needs. Teams in this challenge were tasked with designing an "adaptive education solution for a cognitive classroom that utilizes AI, virtual/augmented reality, and/or robotics to enhance learning and create more inclusive, equitable, and accessible educational experiences." In order to develop these solutions, teams worked through four phases of the Innovation Challenge process: (1) team formation; (2) research, brainstorm, plan; (3) build, test, analyze; and (4) solution presentation. In all, 101 teams comprising 510 students from 66 different countries submitted solutions to this challenge.

Key Takeaways from the Evaluation

Students valued their experience participating in and completing the Innovation Challenge. More than 8 out of 10 students who completed the post-survey reported being satisfied or very satisfied with their experience (88%) or with the outcome of their projects (86%), and three-fourths (76%) said they would recommend the experience to others.[2]

[1] NEOM is an accelerator of human progress and a vision of what a new future might look like. It is a region in northwest Saudi Arabia on the Red Sea being built from the ground up as a destination and a home for dreamers who want to be part of building a new model for exceptional livability, creating thriving businesses and reinventing environmental conservation. NEOM's approach to environmental conservation and regenerative development adheres to five core principles: Understand, Protect, Enhance, Sustain, and Inspire. This is how 95% of NEOM's land and sea will be protected for nature.

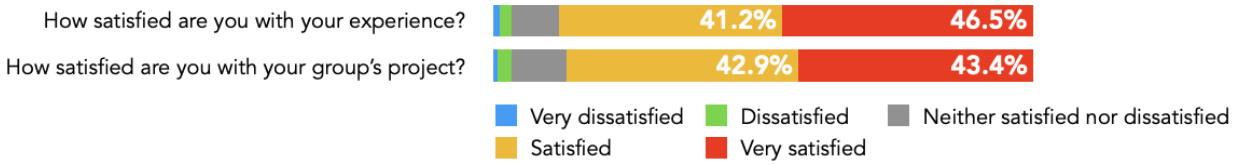
[2] Throughout the report, pre-survey data is based on n=337 completers and post-survey data is based on n=237 completers. The only exceptions are for data on these three statistics: satisfaction with experience (n=211), satisfaction with project outcomes (n=219), and whether students would recommend their experience (n=219).

> *Junior Academy provided me with a platform to collaborate, innovate, and network. Since it was my first time being a part of a challenge, the experience was a roller coaster of emotions. Since a few of my team members were experienced, it pushed me to learn and interact more. I will always remember this experience as a part of my overall journey at New York Academy of Sciences.* — Student

> *I learned a lot from my fellow team members. I believe when you interact with different people, you come to learn about a lot of things going on around the world. Things could have been better if all the students participated equally. But overall, it was a good experience, and working on this project will always remain in my memory as a wonderful experience.* — Student

> *I am not only satisfied with the challenge, but was also left with a good experience that boosted my confidence and skills. It inspired me to pursue more opportunities in this field.* – Student

Figure 1. *Students' Post-survey Rating of Their Overall Satisfaction with the Innovation Challenge*



Students reported greater levels of confidence after completing the Innovation Challenge in all four areas of workforce-related skills measured.[3] Means on all four of the confidence scales were higher in the post-survey than they were in the pre-survey [see *Figure 2*]—with the biggest differences for the communication scale, which measured students' confidence using skills such as presenting ideas, findings, and data in various forms and media—and the creative problem solving scale, which measured students' confidence using skills such as brainstorming solutions, conducting research, analyzing data, and developing solutions to complex problems.

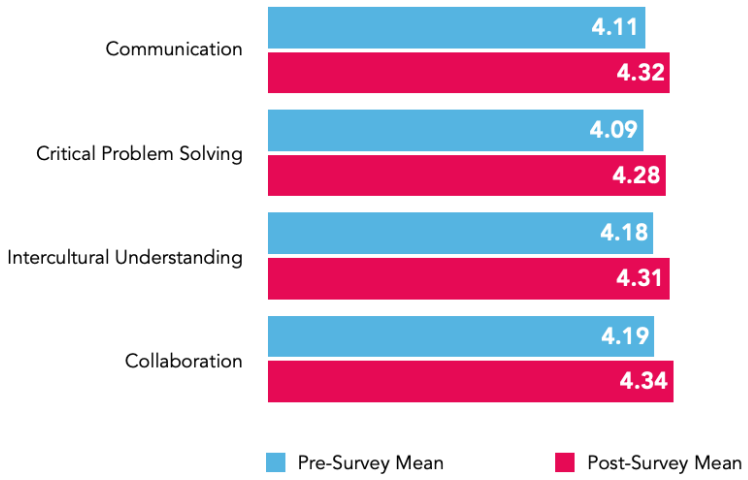
> *I am happy I gained experience in scientific teamwork and coordination. I developed creative thinking, which is not always associated with STEM. Nevertheless, I learned it's very important even in this area.* – Student

[3] In order to preserve the privacy of students' data, the surveys were conducted anonymously—no names, personally identifiable information, or geolocation data were collected. While roughly three-fourths (73%) of the post-survey completers indicated they also completed the pre-survey (another 19% indicated they might have completed the survey), the pre- and post-survey responses are not matched. Throughout this document we report on the difference between the mean scores on the pre-survey and the mean scores on the post-survey.

> *I was very satisfied with my experience participating in the Innovation Challenge because I was able to work with international students to form a solution to a pressing problem. During the challenge experience, I was able to develop vital skills such as time management, problem-solving, and critical thinking.* – Student

> *I was able to collaborate with other people from around the world and learn their perspectives on the topic. I learned valuable information about AI technology and research skills.* – Student

Figure 2. *Mean Scores for the Four Survey Scales (5-point scales, with 1 = not confident and 5 = completely confident)*



Students valued the opportunity to work with, and learn from, peers in different countries and from different cultures. Students reported greater confidence in their ability to understand the perspectives of their peers from other countries and to learn about others' cultures and experiences. They also reported greater interest in wanting to learn from team members. In post-survey open-ended responses, students reported valuing opportunities to "broaden [their] horizons," "explore different cultures," and learn from their teammates' "global perspectives."

> *Despite all of the challenges we faced as a team, I managed to broaden my horizons and explore different cultures and meet people from really really different backgrounds. More importantly, I succeeded at my goal, and I managed to be part of the change. Because, by collaborating with my team members, members that I now get to call friends, we managed to whisk up an innovative solution that will allow us to revolutionize the world once fully and professionally developed. Not only that, but I think that the biggest reward and satisfaction came from our abilities to merge all of our interests and skills together, and share our knowledge with one another.* – Student

> *I am very satisfied with the Innovation Challenge as it helped me develop my leadership skills, attain better team-working skills, and meet new people coming from different backgrounds from all around the world—all sharing a vision of a better world.* – Student

> *It has been a new learning and experience, especially meeting people from other countries and working together in spite of the fact that all live in different time zones.* – Student

Students reported challenges related to team collaboration, including uneven distribution of the work and unresponsive team members. While many students reported valuing their experience learning from diverse peers, they also expressed frustration with the challenges of working in teams. Items related to doing better work when collaborating with others, working in pairs or small groups to complete a task, and working with others to set goals or create a plan are where we observed the least amount of difference between the pre- and post-surveys. In open-ended responses, students discussed challenges with team members who "wouldn't respond," who were "rather inactive," or who "lost interest" as the challenge progressed.

> *I felt the participation of the team could have been better and more pronounced, although I was satisfied with the product itself.* – Student

> *The Innovation Challenge definitely helped me develop as a person, and pushed me to think outside the box as I had to come up with solutions and draw inferences from surveys. However, in the pursuit to find a mentor, I was incorrectly provided with team members, where most of them were irresponsive. Hence, I found collaborating on the project with others extremely difficult and time consuming.* – Student

> *The Innovation Challenge allowed me to learn beyond the classroom and collaborate with global peers to develop innovative solutions in Cognitive Classrooms. However, there has been a lack of active team discussions and mentorship so the work was not as efficiently done as it should have been. Otherwise, it's a good experience overall.* – Student

Specific Findings

The evaluation measured students' confidence with four key workforce related skills: creative problem solving, communication, collaboration, and intercultural understanding. In addition, survey items probed students' attitudes toward teamwork.

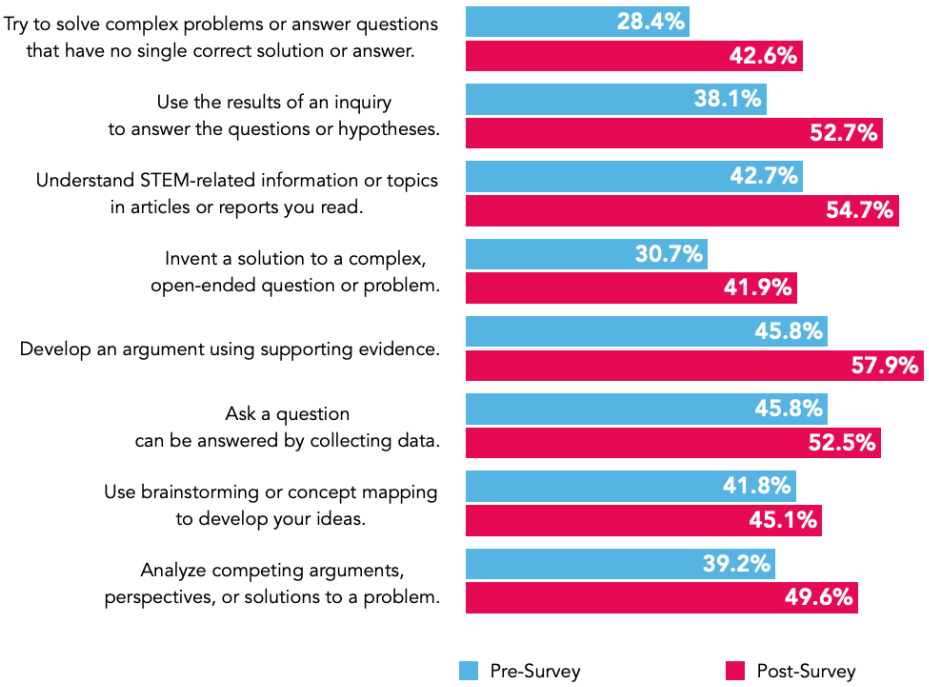
Creative Problem Solving

In order to design their solutions, teams are tasked with using design thinking methods to research the topic, then to brainstorm, develop, and test their solution. Successfully completing these tasks requires a number of creative problem-solving skills, including the analysis of complex problems, investigation of questions for which there are no definitive answers, evaluation of information sources and use of appropriate evidence to draw conclusions, generation of solutions to complex problems or tasks based on analysis and synthesis of information, and the combination or presentation of the results in new and original ways.[4]

[4] Ravitz, J. (2014). A Survey for Measuring 21st Century Teaching and Learning: West Virginia 21st Century Teaching and Learning Survey. https://evaluationbydesign.com/wp-content/uploads/WVDE_21CS/WVDE_21cs_A_survey_for_measuring_21st_century_teaching.pdf

Students on the post-survey reported greater levels of confidence in their ability to use each of these skills when compared to the pre-survey. Interestingly, the *ability to solve complex problems*—one of the skills students on the pre-survey felt least confident about—is the skill where the greatest difference in the post-survey was observed. Similarly, 15% more students reported in the post-survey they were *completely confident* using the results of an inquiry to answer questions or hypotheses, and 12% more felt completely confident understanding STEM-related information in articles they read—two skills they would have particularly required when completing the challenge.

Figure 3. *Percentage of Students who Reported Being completely confident Using Creative Problem-Solving Skills*



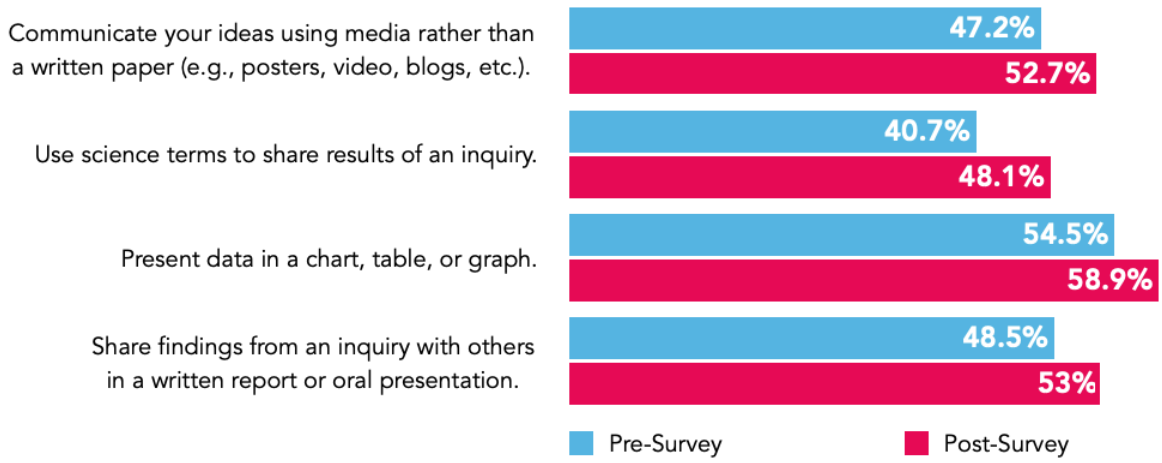
Communication

In the final stage of the project, students submit presentations of their solutions to a panel of judges. Presentations must include discussions of the problem, background information, a hypothesis, the team's methods, their results, and their solution. The majority of teams submit their final products as slide deck presentations, but they also are allowed to submit video presentations.

Of the four skills areas, students' confidence in their ability to use communication skills was where the greatest difference was observed. These skills include the ability to organize thoughts, data, and findings and the ability to share these findings effectively through a variety of media, including written reports, oral presentations, and digitally (Ravitz, 2014). The

differences recorded are likely significant, given the relatively short month-long period of this challenge and the fact that many students are not native English speakers.

Figure 4. *Percentage of Students who Reported Being completely confident Using Communication Skills*

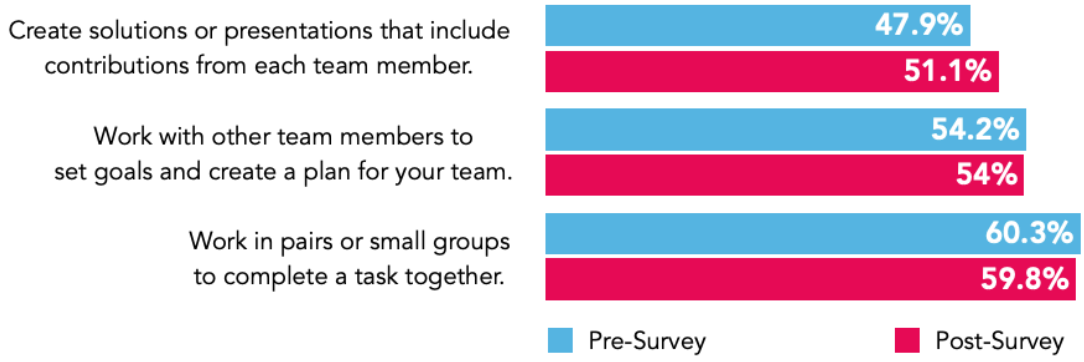


Collaboration

Students who participate in Innovation Challenges typically work in teams of 4–6 individuals, which they join during the team formation period. Typically, students select or create teams based on interest in the topic, originality of a solution idea, leadership, and availability. During the first phase of the project, teams are tasked with getting to know each other—including learning about personal information as well as relevant skills and expertise—and developing a plan for how they will communicate and work together to achieve their goals.

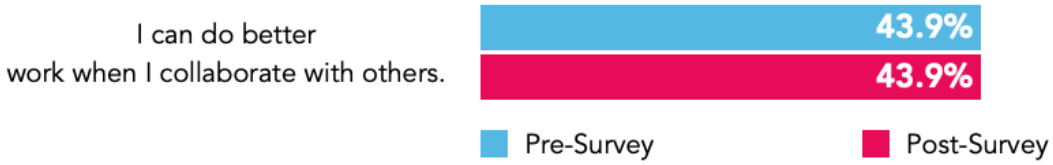
As noted in the key takeaways section, inactive team members or team members who did not do their share of the work were frequently cited as frustrations in post-survey open-ended responses. While the pre- to post-survey difference on these items was still positive, we observed the least amount of difference in the collaboration scale.

Figure 5. *Percentage of Students who Reported Being completely confident Using Collaboration Skills*



Students' perceptions of the value added by working collaboratively remained relatively low in the post-survey and *I can do better work when I collaborate with others* was the only survey item where there was no difference from pre- to post-survey.

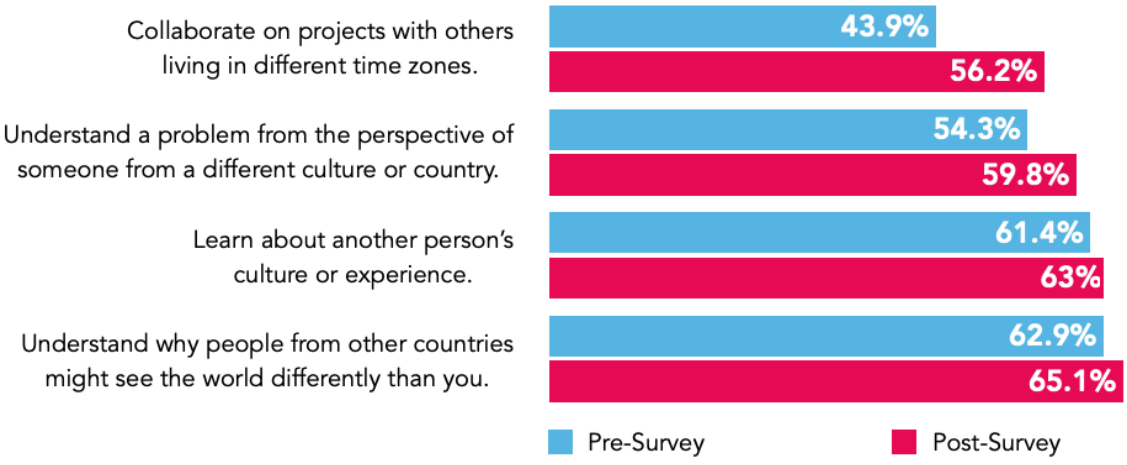
Figure 6. *Percentage of Students who Reported strongly agreeing with the Following Teamwork Perspective Statement*



Intercultural Understanding

Despite the challenges of working with others, students discussed in open-ended responses how exciting it was to work with peers from around the world and noted that they gained both inspiration and knowledge from their teammates. It is interesting to note that when students were asked in the pre-survey to discuss the challenges they thought they might encounter, they often worried about their ability to coordinate team meetings across time zones. While this remained a theme in post-survey open-ended responses, students' confidence in their ability to collaborate with others across time zones had one of the greatest differences in pre- to post-survey responses.

Figure 7. *Percentage of Students who Reported Being completely confident Using Intercultural Understanding Skills*



Conclusion

During the month-long Fall 2023 Innovation Challenge on cognitive classrooms, students reported gaining confidence in key workforce-related skills and detailed their enthusiasm for the experience in their open-ended responses.

- Students valued their experience participating in and completing the Innovation Challenge.
- Students reported greater levels of confidence in all four areas of workforce-related skills after completing the Innovation Challenge.
- Students valued the opportunity to work with, and learn from, peers in different countries and from different cultures.
- Students reported challenges related to team collaboration, including uneven distribution of the work and unresponsive team members.

In future Innovation Challenges, the Academy might look for ways to address inactive team members and the difficulties around collaboration. Some participants suggested a more rigorous application process, a better way to check on the work done by team members and to identify non-contributing members as inactive, and better platforms for meeting that allow groups to meet if the group's leader is absent. While drop-off is present in many online and informal educational experiences, the Academy also might want to focus future evaluations particularly on those students who become inactive in order to learn whether there are ways to better support them.

Appendices

Appendix A: Methods

Instrument Development

EDC worked in collaboration with staff from the Academy to develop four pre/post-survey scales through an iterative process.

EDC began by reviewing relevant preexisting instruments and gathered a draft list of 85 items for the four scales. EDC and staff from the Academy then reviewed the draft list, collecting notes and rating each item from 1–3 based on whether the item was (a) relevant to the Innovation Challenge, (b) understandable to the students, and (c) likely to change as a result of participating in the Innovation Challenge. We then completed a second review of the 42 top-rated items, noting language revisions and coverage of key areas, and selected 25 items for Version 1 of the survey.

EDC then conducted one cognitive interview with an Innovation Challenge alumni and met with staff from the Academy to discuss findings from that interview and make a subsequent set of revisions to develop the final survey consisting of 23 pre/post-survey Likert scale items, as well as several pre-only and post-only items (see *Appendices C* and *D* for the full surveys).

Data Collection and Analysis

In total, 337 students completed the pre-survey and 237 students completed the post-survey (completers were considered students who completed more than ⅓ of the survey). The pre-survey was completed in the first week of October, 2023—just after teams had been formed—and the post-survey was completed in the first week of November, 2023 after teams had submitted their final projects.

The pre- and post-surveys were loaded into the online survey platform Qualtrics and results were downloaded into SPSS. To explore differences in pre-to-post-survey findings, we calculated the means for individual items and for each of the four scales and subtracted the pre-survey mean from the post-survey mean.

Open-ended responses were imported into the qualitative data analysis tool Atlas.ti and analyzed thematically.

Limitations

In order to preserve the privacy of students' data, the surveys were conducted anonymously. While roughly three-fourths (73%) of the post-survey completers indicated they also completed the pre-survey (another 19% indicated they might have completed the survey), the responses are not matched. This limits the ability to make claims on pre- to post-survey changes. Throughout this document we report on the *difference* between the mean scores on the pre-survey and the mean scores on the post-survey.

Participants

Pre-Survey Participant Statistics

- **n:** 337
- **Average Age**: 15.8 years old
- **Percentage who reported participating in previous Innovation Challenges:** 89%

Post-Survey Participant Statistics

- **n:** 237
- **Average Age**: 15.7 years old
- **Percentage who reported participating in previous Innovation Challenges:** 87%

Appendix B: Pre- and Post-Survey Mean Scores

Creative Problem Solving

Item	Pre-Survey Mean	Post-Survey Mean	Difference
Try to solve complex problems or answer questions that have no single correct solution or answer.	3.8131	4.1308	0.3177
Ask a question that can be answered by collecting data.	4.1543	4.3165	0.1622
Understand STEM-related information or topics in articles or reports you read.	4.1869	4.3924	0.2055
Analyze competing arguments, perspectives, or solutions to a problem.	4.1988	4.2405	0.0417
Use brainstorming or concept mapping to develop your ideas.	4.1721	4.2954	0.1233
Invent a solution to a complex, open-ended question or problem.	3.9347	4.1392	0.2045
Develop an argument using supporting evidence.	4.1988	4.3629	0.1641
Use the results of an inquiry to answer the questions or hypotheses.	4.0950	4.3544	0.2594

Communication

Item	Pre-Survey Mean	Post-Survey Mean	Difference
Present data in a chart, table, or graph.	4.2196	4.4093	0.1897

Share findings from an inquiry with others in a written report or oral presentation.	4.1840	4.3629	0.1789
Communicate your ideas using media rather than a written paper (e.g., posters, video, blogs, etc.).	4.0267	4.2911	0.2644
Use science terms to share results of an inquiry.	4.0089	4.2025	0.1936

Intercultural Understanding

Item	Pre-Survey Mean	Post-Survey Mean	Difference
Understand why people from other countries might see the world differently than you.	4.3264	4.4641	0.1377
Understand a problem from the perspective of someone from a different culture or country.	4.1840	4.3418	0.1578
Learn about another person's culture or experience.	4.3116	4.4599	0.1483
Collaborate on projects with others living in different time zones.	3.9228	4.2278	0.305

Collaboration

Item	Pre-Survey Mean	Post-Survey Mean	Difference
Work in pairs or small groups to complete a task together.	4.2878	4.3376	0.0498
Work with other team members to set goals and create a plan for your team.	4.1899	4.3122	0.1223
Create solutions or presentations that include contributions from each team member.	4.0950	4.2447	0.1497

Teamwork Perspectives

Item	Pre-Survey Mean	Post-Survey Mean	Difference
I suggest alternative solutions to problems.	4.0682	4.2869	0.2187
I believe I am a good leader.	4.1098	4.2574	0.1476
I learn from other team members.	4.4926	4.6287	0.1361
I can do better work when I collaborate with others.	4.0534	4.0802	0.0268

Appendix C: Pre-Survey

Introduction

Innovation Challenge Pre-Survey
You are being asked to complete two brief surveys (about 10 minutes), one before and one after you complete finish the Innovation Challenge you are participating in. Your responses to these surveys will help the New York Academy of Sciences learn about participants' experiences in the Innovation Challenges and improve future challenges.

Please read the information below, which describes the data being collected and how that data will be used. Check the box at the end if you agree to complete the survey.

Survey Items Introduction

The following survey items ask you to rate your confidence or attitudes towards a series of skills such as problem solving, communication, and teamwork. Please read each item carefully and answer as truthfully as possible.

Scale 1: Creative Problem Solving

Please tell us how confident you are that you can do the following:

	Not confident	Slightly confident	Somewhat confident	Fairly confident	Completely confident
Use brainstorming or concept mapping to develop your ideas	○	○	○	○	○
Invent a solution to a complex, open-ended question or problem	○	○	○	○	○

Analyze competing arguments, perspectives or solutions to a problem	○	○	○	○	○
Develop an argument using supporting evidence	○	○	○	○	○
Try to solve complex problems or answer questions that have no single correct solution or answer	○	○	○	○	○
Understand STEM-related information or topics in articles or reports you read.	○	○	○	○	○
Ask a question that can be answered by collecting data.	○	○	○	○	○
Use the results of an inquiry to answer the questions or hypotheses.	○	○	○	○	○

Scale 2: Communication

Please tell us how confident you are that you can do the following:

	Not confident	Slightly confident	Somewhat confident	Fairly confident	Completely confident
Present data in a chart, table, or graph.	○	○	○	○	○
Share findings from an inquiry with others in a written report or oral presentation.	○	○	○	○	○
Communicate your ideas using media rather than a written paper (e.g., posters, video, blogs, etc.).	○	○	○	○	○
Use science terms to share results of an inquiry.	○	○	○	○	○

Scale 3: Collaboration and Intercultural Understanding

Please tell us how confident you are that you can do the following:

	Not confident	Slightly confident	Somewhat confident	Fairly confident	Completely confident

Work in pairs or small groups to complete a task together	○	○	○	○	○
Work with other team members to set goals and create a plan for your team	○	○	○	○	○
Create solutions or presentations that include contributions from each team member	○	○	○	○	○
Understand why people from other countries might see the world differently than you.	○	○	○	○	○
Understand a problem from the perspective of someone from a different culture or country.	○	○	○	○	○
Learn about another person's culture or experience.	○	○	○	○	○
Collaborate on projects with others living in different time zones.	○	○	○	○	○

Scale 4: Teamwork perspectives

Think of times when you've worked with others in groups or on teams, how much do you agree or disagree with the following statements?

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I suggest alternative solutions to problems.	○	○	○	○	○
I believe I am a good leader.	○	○	○	○	○
I learn from other team members	○	○	○	○	○
I can do better work when I collaborate with others.	○	○	○	○	○

Open-Ended Pre-Survey Questions

Is there anything that you hope to learn or gain from participating in the Innovation Challenge?

Is there anything you're worried about, or that you think you'll find particularly challenging?

Demographics/Info about the participant

How old are you?

Is this your first time participating in a New York Academy of Sciences Innovation Challenge?

- Yes
- No
- Not sure

	Not confident	Slightly confident	Somewhat confident	Fairly confident	Completely confident
How confident do you feel communicating in English?	○	○	○	○	○

Appendix D: Post-Survey

Introduction

Innovation Challenge Post-Survey
This is the second of two brief surveys you've been asked to complete. This survey should take about 10 minutes to complete. Your responses to these surveys will help the New York Academy of Sciences learn about participants' experiences in the Innovation Challenges and improve future challenges.

Please read the information below, which describes the data being collected and how that data will be used. Check the box at the end if you agree to complete the survey.

Survey Items Introduction

The following survey items ask you to rate your confidence or attitudes towards a series of skills such as problem solving, communication, and teamwork. Please read each item carefully and answer as truthfully as possible.

Scale 1: Creative Problem Solving

Please tell us how confident you are that you can do the following:

	Not confident	Slightly confident	Somewhat confident	Fairly confident	Completely confident
Use brainstorming or concept mapping to develop your ideas	○	○	○	○	○
Invent a solution to a complex, open-ended question or problem	○	○	○	○	○
Analyze competing arguments, perspectives or solutions to a problem	○	○	○	○	○
Develop an argument using supporting evidence	○	○	○	○	○
Try to solve complex problems or answer questions that have no single correct solution or answer	○	○	○	○	○
Understand STEM-related information or topics in articles or reports you read.	○	○	○	○	○
Ask a question that can be answered by collecting data.	○	○	○	○	○
Use the results of an inquiry to answer the questions or hypotheses.	○	○	○	○	○

Scale 2: Communication

Please tell us how confident you are that you can do the following:

	Not confident	Slightly confident	Somewhat confident	Fairly confident	Completely confident
Present data in a chart, table, or graph.	○	○	○	○	○

Share findings from an inquiry with others in a written report or oral presentation.	○	○	○	○	○
Communicate your ideas using media rather than a written paper (e.g., posters, video, blogs, etc.).	○	○	○	○	○
Use science terms to share results of an inquiry.	○	○	○	○	○

Scale 3: Collaboration and Intercultural Understanding

Please tell us how confident you are that you can do the following:

	Not confident	Slightly confident	Somewhat confident	Fairly confident	Completely confident
Work in pairs or small groups to complete a task together	○	○	○	○	○
Work with other team members to set goals and create a plan for your team	○	○	○	○	○
Create solutions or presentations that include contributions from each team member	○	○	○	○	○
Understand why people from other countries might see the world differently than you.	○	○	○	○	○
Understand a problem from the perspective of someone from a different culture or country.	○	○	○	○	○
Learn about another person's culture or experience.	○	○	○	○	○
Collaborate on projects with others living in different time zones.	○	○	○	○	○

Scale 4: Teamwork perspectives

Think of times when you've worked with others in groups or on teams, how much do you agree or disagree with the following statements?

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree

I suggest alternative solutions to problems.	○	○	○	○	○
I believe I am a good leader.	○	○	○	○	○
I learn from other team members	○	○	○	○	○
I can do better work when I collaborate with others.	○	○	○	○	○

Post-Only questions

Overall, how satisfied were you with your experience participating in the Innovation Challenge?

- Very satisfied
- Satisfied
- Neither satisfied nor dissatisfied
- Dissatisfied
- Very dissatisfied

Please write a sentence or two explaining your answer.

How satisfied are you with the outcome of your group project?

- Very satisfied
- Satisfied
- Neither satisfied nor dissatisfied
- Dissatisfied
- Very dissatisfied

Please write a sentence or two explaining your answer.

How well do you think your group worked together?

- Extremely well
- Very well
- Moderately well
- Slightly well
- Not well at all

Please write a sentence or two explaining your answer.

Did your group work with a mentor?

- Yes
- No

  If yes

  How satisfied are you with your experience with the group's mentor?
  - Very satisfied
  - Satisfied
  - Neither satisfied nor dissatisfied
  - Dissatisfied
  - Very dissatisfied

Would you recommend this program to your friends?
- Yes
- No
- Maybe

Please provide any additional comments or suggestions you have about the Innovation Challenge.

Demographics/Info about the participant

Did you also complete the pre-survey, which was sent at the beginning of October?

- Yes

- No
- Not sure

How old are you?

Is this your first time participating in a New York Academy of Sciences Innovation Challenge?

- Yes
- No
- Not sure

	Not confident	Slightly confident	Somewhat confident	Fairly confident	Completely confident
How confident do you feel communicating in English?	○	○	○	○	○