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Expanding Pre-College Access to NASA Artemis Mission: The 2025 NASA Opportunities Awareness & STEM Enrichment Summer Workshop at the University of the District of Columbia

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Expanding Pre-College Access to NASA Career Readiness: The 2025 NASA Opportunities Awareness & STEM Enrichment Summer Workshop at the University of the District of Columbia (UDC)

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Abstract

This work in progress paper presents the 2025 NASA Opportunities Awareness & STEM Enrichment Summer Workshop, a two-week program designed to inspire local high school students to pursue STEM careers and increase awareness of pathways into the aerospace workforce. The workshop was developed through a partnership between a public university and a regional education agency, and integrated hands-on engineering activities, including CAD modeling, additive manufacturing, battery systems, and robotics. A total of 45 high school students participated in the program, engaging in discipline-specific modules that introduced core concepts from mechanical, civil, biomedical, and computer engineering. These modules were designed to provide students with foundational exposure to different engineering fields and to support informed decision-making regarding future academic and career pathways.

In addition to technical content, the workshop incorporated sessions on NASA opportunities and professional skills to prepare students for the multidisciplinary nature of the STEM workforce. Guest speakers from NASA's Office of STEM Engagement (OSTEM) introduced the Artemis mission and highlighted opportunities for student involvement, including internships, student challenges, and career pathways across STEM disciplines such as aerospace, mechanical, electrical, and computer engineering, as well as related fields including physics, mathematics, and selected non-STEM roles supporting NASA missions.

This paper presents the workshop curriculum, the university school district collaboration model, engineering activities to increase the awareness of STEM opportunities in aerospace industry and students' self-reported knowledge and attitude changes towards STEM opportunities following the workshop. Findings indicate an increase in students' awareness of NASA STEM-related opportunities, with 86% of participants able to identify examples of research opportunities and NASA student challenges following the workshop, compared to 44% prior to participation. The significant increase in STEM awareness proves the effectiveness of this university school district collaboration in connecting pre-college students to the national STEM workforce, particularly for aerospace agencies such as NASA.

Keywords: STEM, NASA Opportunity, career readiness internship, university-state collaboration, engineering awareness

Introduction

Pre-college engineering education (PCEE) initiatives have increasingly focused on developing early pathways into STEM by exposing students to authentic engineering experiences, career awareness, and hands-on problem-solving. Early exposure has been shown to play a critical role in shaping students' academic and career trajectories, with many students reporting interest in STEM fields prior to entering college [1]. Programs such as Project Lead the Way (PLTW), summer camps, and university-based outreach initiatives have demonstrated positive outcomes in increasing student interest, engagement, and persistence in STEM disciplines, particularly among underrepresented populations [2], [3], [4].

A common feature across successful PCEE programs is the integration of experiential, project-based learning that connects theoretical concepts to real-world applications. These approaches not only improve conceptual understanding but also foster critical thinking, collaboration, and creativity; skills essential for engineering practice [2], [5]. In addition, partnerships between universities, school districts, and external organizations (e.g., industry or government agencies) have been shown to enhance program effectiveness by providing access to facilities, mentorship, and authentic STEM contexts [3], [6].

Despite these advances, several challenges remain within the PCEE. First, while many programs report increases in student interest and self-efficacy, there is still a need for robust and scalable methods to assess student learning outcomes, particularly in engineering design and applied skills [2]. Second, there is a need for replicable program models that can be adapted across different institutional and geographic contexts [3]. Third, while many outreach programs focus on hands-on activities, fewer explicitly connect these activities to clear career pathways, such as internships, research opportunities, or workforce entry points.

To address these gaps, this paper presents the implementation and self-reported evaluation of a two-week NASA-focused STEM enrichment workshop designed to increase awareness of engineering pathways and build foundational technical skills for students in the local community. The workshop integrates hands-on modules in additive manufacturing, energy systems, embedded systems, and robotics with structured exposure to NASA-related opportunities and career pathways, including internships, competitions, and career pathways. The program is implemented through a university-school district partnership aimed at broadening participation and increasing access to STEM opportunities.

Program Overview

The NASA Artemis mission and the broader aerospace industry represent a critical growth area for the future STEM workforce. However, accessible, early-exposure pathways into these high-demand careers remain limited, particularly for high school students from local communities [7]. Aligned with NASA's OSTEM 2025 strategic priorities, which emphasize accelerating student entry into aerospace jobs and widening participation to include skilled technical workforce development, this initiative adopts a targeted, state-based approach [8]. Furthermore, it aims to increase enrollment and retention in NASA-infused engineering programs at the University of the District of Columbia by engaging local high schools and community colleges to cultivate a diverse, future-ready STEM workforce.

As a NASA MUREP Award recipient, a team of the University of the District of Columbia (UDC) engineering faculty and students developed the 2025 NASA Opportunities Awareness & STEM Enrichment Summer Workshop at UDC to increase STEM awareness to local high school students. This program was created through a strategic collaboration with the state's Office of the State Superintendent of Education (OSSE) via the Career Ready Internship (CRI) program. This practice-based paper details the workshop's design, implementation, and initial outcomes, hosted by UDC's Center for Advanced Manufacturing in Space Technology & Applied Research (CAM-STAR). Over the course of the program, 45 participants engaged in integrated engineering activities, including CAD modeling, 3D printing, lithium-ion battery labs, and a robotics competition, culminating in a scientific poster presentation. These were complemented by sessions focused on NASA opportunities and professional skill development. Evaluation of the workshop assessed both instructional effectiveness and affective impact. Key metrics included changes in participants' self-reported knowledge and skills, as well as shifts in STEM career interest.

The workshop primarily engaged 45 students from the local community aging from 15-18, with 75% of participants attending local high schools. The remaining students were from neighboring states, reflecting the broader outreach and regional enrollment profile of UDC. As a public university, UDC's student body is predominantly composed of residents (80-85%), with most other students coming from the surrounding Maryland and Northern Virginia areas. Consequently, all participants represent UDC's target demographic for undergraduate enrollment and future STEM pathway development.

The paper presents the curriculum framework, the university school district collaboration model, broad outreach to public high schools for the future STEM pipelines at UDC, and students' self-reported knowledge and attitude changes. More students reported their knowledge of STEM and NASA opportunities increased significantly. These findings prove the effectiveness of the institutions and school district collaboration building the bridge pre-college education pipeline with the evolving needs of the national aerospace and STEM workforce; and it also provides a scalable replicable example with specific activity tied to clear career pathways in aerospace and STEM workforce

Innovative Practice

To maximize the participants' engagement, the faculty and instructors utilized active learning strategies [9], including group discussion, hand-on activities such as 3D printing, and assembling rover, and group presentation. To make it more effective for students to be aware of the NASA Opportunities and how they can be involved, the workshop is developed with the following steps:

1. Overview of NASA Artemis mission to return humans back to the moon, and relevant opportunities for students to participate, such as NASA internship, NASA student challenges etc.

2. Introducing projects related to NASA Artemis such as additive manufacturing components, design and assembling rover for planet exploration, and lithium-ion batteries and solar panel batteries to power the scientific equipment in space missions.
3. Having the students present the learning through interactive robotic challenges and poster presentations to practice presenting skills.
4. Provide responsive feedback based on the presentation.
5. Reinforce the opportunities that the students could participate in to be part of the Artemis generation.

Learning Objectives:

The partnership framed the workshop around three core objectives to help the students to have the awareness of STEM opportunities and hands-on activities to provide real world engineering experience in aerospace industry like NASA:
(1) With the essential question in mind that how can we design and build sustainable, functional technologies for space exploration using the tools and materials available on Earth, we designed several hands-on projects to increase the students' interest in STEM.
(2) Through case study of Mars Spirit Rover, and the NASA guest speaker, we covered NASA Artemis mission, milestones, timelines, and how students in different levels can participate in through NASA student challenge, internship, competitions etc. to enhance awareness of NASA opportunities.
(3) With hands-on projects, UDC faculties and instructors demonstrate the necessary engineering skills such as designing, modeling, measuring, decision matrix and result analysis, evaluating, teamworking etc. which provides real-world work experience, professional mentorship, and transferable workplace skills.

Workshop Structure:

The workshop starts with orientation to introduce the program to kick off the 2 weeks long workshop, following the invited talk about NASA Artemis Mission and Career Opportunities. And following the afternoon, we assigned students into groups of 4 or 5 students and started the technical introduction of the software and hardware needed in the projects. Afterwards, in the morning, we introduce different modules of the projects and have discussions; and in the afternoon, students will work in groups on the projects. The instructors checked each group to offer support and help within the project scope. The last day, each group of students first demonstrated their learning through a poster; following with a live demo of their designed 3D printed, and lithium-ion battery powered lunar rover to move to a designated location on the simulant grave to imitate the lunar surface and retrieve the astronaut from mission field and bring the astronaut back to home base safely. Table 1 shows the schedule for the NASA Opportunities Awareness & STEM Enrichment Summer Workshop and the details of the activities of each day with the topic for each day.

TABLE I. Agenda of the NASA Opportunities Awareness & STEM Enrichment Summer Workshop

Date	Topic	Schedule	Activities
Day 1	Kickoff & CAD Foundations	9:30 – 10:00 AM	Introduction and Workshop Orientation
		10:00 – 11:45 AM	Welcome Remarks & Guest Talk: NASA Artemis Missions & Opportunities
		12:00 PM – 1:00 PM	LUNCH BREAK
		1:00 – 3:00 PM	CAD Workshop
Day 2	Team logo design workshop	10:00 – 11: 30 AM	OnShape Deep Dive
		12:00 – 1:00 PM	LUNCH BREAK
		1:00 – 3:00 PM	Team Logo Creation
Day 3	Logo printing & rover intro	10:00 – 11: 30 AM	3D Print Team Logos
		12:00 – 1:00 PM	LUNCH BREAK
		1:00 – 3:00 PM	Meet the Rover/EV Car and Learn key components & mechanics!
Day 4	Rover parts fabrication	10:00 – 11: 30 AM	3D Printing Rover Components
		12:00 – 1:00 PM	LUNCH BREAK
		1:00 – 3:00 PM	Continued 3D Printing & Assembly Preparation
Day 5	Power systems & EV race	10:00 – 11: 30 AM	Lunar Energy Workshop
		12:00 – 1:00 PM	LUNCH BREAK
		1:00 – 3:00 PM	Rover/EV Car Race Challenge
Day 6	Rover assembly	10:00 – 11: 30 AM	Lunar Rover Assembly
		12:00 – 1:00 PM	LUNCH BREAK
		1:00 – 3:00 PM	Complete Rover Construction
Day 7	Rover parts fabrication	10:00 – 11: 30 AM	Intro to Rover Programming
		12:00 – 1:00 PM	LUNCH BREAK
		1:00 – 3:00 PM	Straight-Line Path Test
Day 8	Advanced coding & rescue preparation	10:00 – 11: 30 AM	Code Modifications
		12:00 – 1:00 PM	LUNCH BREAK
		1:00 – 3:00 PM	Final Rescue Mission Practice
Day 9	Grand finale!	10:00 – 11: 30 AM	Team Presentations & Rover Rescue Challenge
		11:30 AM – 12:00 PM	Awards Ceremony
		12:00 – 1:00 PM	Closing out Lunch!

Activities:

The two-week workshop was structured to sequentially build student competencies in digital manufacturing, robotics, and embedded systems, culminating in a capstone design challenge. The curriculum was framed by the essential question: "How can we design and build sustainable, functional technologies for space exploration using the tools and materials available on Earth?" This guiding question directly connected the week's activities to authentic, real-world STEM challenges like NASA's Mars rover missions.

Week 1: Digital Design, Manufacturing, and Rover Prototyping

The first week enabled the students to gain skills in computer-aided design (CAD) and manufacturing, with an emphasis on engineering communication and iterative prototyping. Following an introductory lesson of space exploration challenges, such as mobility on lunar terrain, limited energy, and the need for lightweight structures, students were introduced to Onshape as a CAD platform suitable for team collaboration. Students first completed structured CAD activities by designing team logos and custom phone cases. These models served as easy-to-follow entry practice models for learning essential CAD operations such as sketch constraints, extrusions, fillets, dimensioning, exporting for manufacturing while also building team identity.

Teams were tasked with modeling a chassis compatible with solar or battery power, emphasizing constraints such as component mounting and structural rigidity. Students prepared their designs for production using slicing software and fabricated parts with 3D printers, introducing key additive manufacturing concepts such as layer orientation, infill percentage, support structures, tolerances, and print-time tradeoffs. To broaden their understanding of manufacturing processes, students also participated in a supervised introduction to subtractive manufacturing through a university machine shop tour and demonstrations. This experience reinforced safety, tool selection, and the distinction between design intent and manufacturability.

To support engineering thinking and technical communication, teams documented their design decisions using decision matrices including chassis geometry options, wheel types, material choices and mounting strategies, and maintained progress posters that were updated daily. Posters included annotated CAD screenshots, photos of printed parts, test notes, and performance observations. The week concluded with a rover prototyping competition focused on speed and mechanical performance, where teams optimized servo, gear, and wheel assemblies and discussed how variables such as voltage, torque, friction, wheel diameter, and weight distribution influenced outcomes. This structured mini-competition encouraged iteration, troubleshooting, and evidence-based improvement, while also reinforcing teamwork and time management during constrained build windows.

Week 2: Embedded Systems Integration and the Capstone Challenge

The second week focused on embedded systems integration and the development of autonomous rover behaviors through electronics assembly and programming. Students started with Arduino basics using LED circuits to learn breadboards, polarity, resistors, and digital outputs. After that, they progressed to control DC motors with an L298N H-Bridge, learning how Pulse Width Modulation (PWM) can adjust speed and how logic signals control direction.

Afterwards, teams integrated full rover systems by mounting DC motors, wheels, a battery pack, and a Pixy2 vision sensor onto a provided rover chassis. This activity emphasized engineering skills, including cable management, secure mounting, troubleshooting connections, and ensuring compatibility between mechanical design and electrical wiring. Teams then programmed motor test routines, forward/reverse movement control, turning, and sensor detection, verifying each subsystem before merging code into a complete routine. Teams then programmed the rover for autonomous behavior. Using Pixy2, students coded the rover to detect a colored target, drive toward it, and return to a home base. They tested and refined their code through trial and error on a course imitating lunar soil.

The workshop ended with the Mars R.E.T.R.I.E.V.E. Challenge. Each team first presented a technical poster describing their literature review, rover design choices, energy source comparisons, system integration approach, and each member's contributions. Then teams deployed their autonomous rovers into a lunar terrain-like track to locate and retrieve a color-coded object and return it to a home base. Judges provided feedback on both the poster and rover performance, which gave students a well-rounded assessment focused on mechanical design, coding, sensor integration, and overall systems thinking.

Results

At the conclusion of the workshop, participants completed a retrospective pre- and post-survey self-reporting knowledge of NASA opportunities. On the last day of the workshop, students (N=45) completed surveys indicating their knowledge across 14 different skills before (retroactively) and after activities on a 7-point Likert Scale (Strongly Agree, Agree, Somewhat Agree, Neither Agree or Disagree, Somewhat Disagree, Disagree, Strongly Disagree; see Figure 1). Descriptively, compared to before the workshop, more students agreed or strongly agreed that after the workshop they can give examples of NASA research opportunities for advanced manufacturing, rover, and student challenges (Mean Percent Agree Before = 44%; Mean Percent Agree After = 86%). The median student ratings were higher after the workshop for all items (see Figure 1).

Students also described their abilities along a range of technical skills, including how to use electrical wiring for robotic vehicle, explain engineering design process, give examples of energy sources, give examples of how lithium batteries work, use advanced manufacturing technology, use Arduino boards for robotic vehicles, use CAD software, use cameras to detect objects with machine learning, and use the decision matrix for rover design. More students agreed or strongly agreed they knew how to use these technologies after the workshop compared to before (Mean Percent Agree Before = 54%, SD=13%; Mean Percent Agree After = 89%, SD=4%).

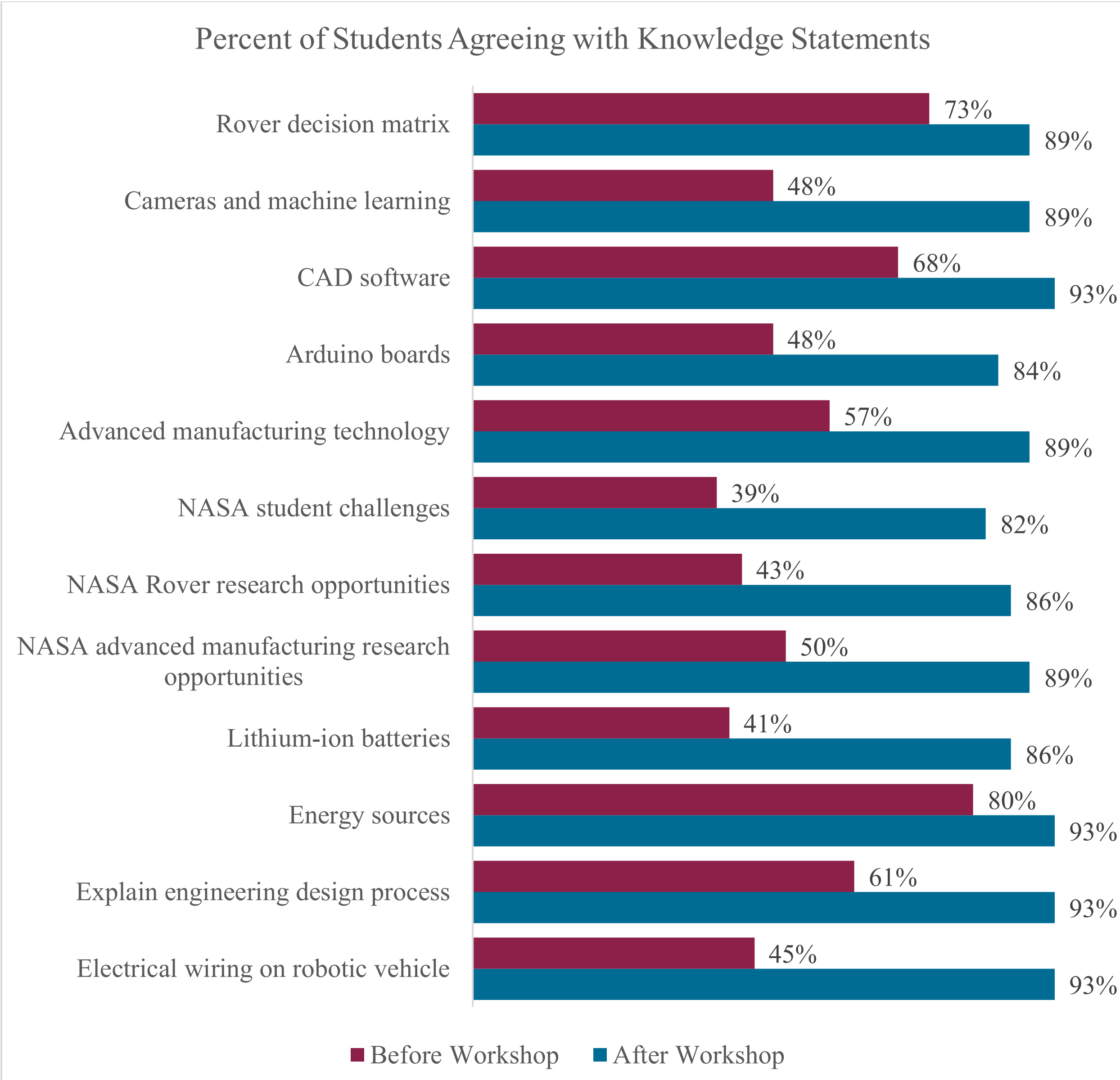

FIGURE 1. Description of Students' Self-Reported Knowledge

A Wilcoxon Signed Ranks Test of median item level ratings showed significantly higher ranks for knowledge after as compared to before the workshop. Median ratings were used to accommodate the ordinal scale used for the ratings (see Figure 2). Overall, the majority of students (69%) rated their knowledge higher after the workshop, 27% the same, and 4% lower. Students' median knowledge rating across 13 indicators before was 5 (Somewhat Agree) compared to 6 (Agree) after the workshop. These differences are statistically significant ($Z=-4.785$, $p<.001$).

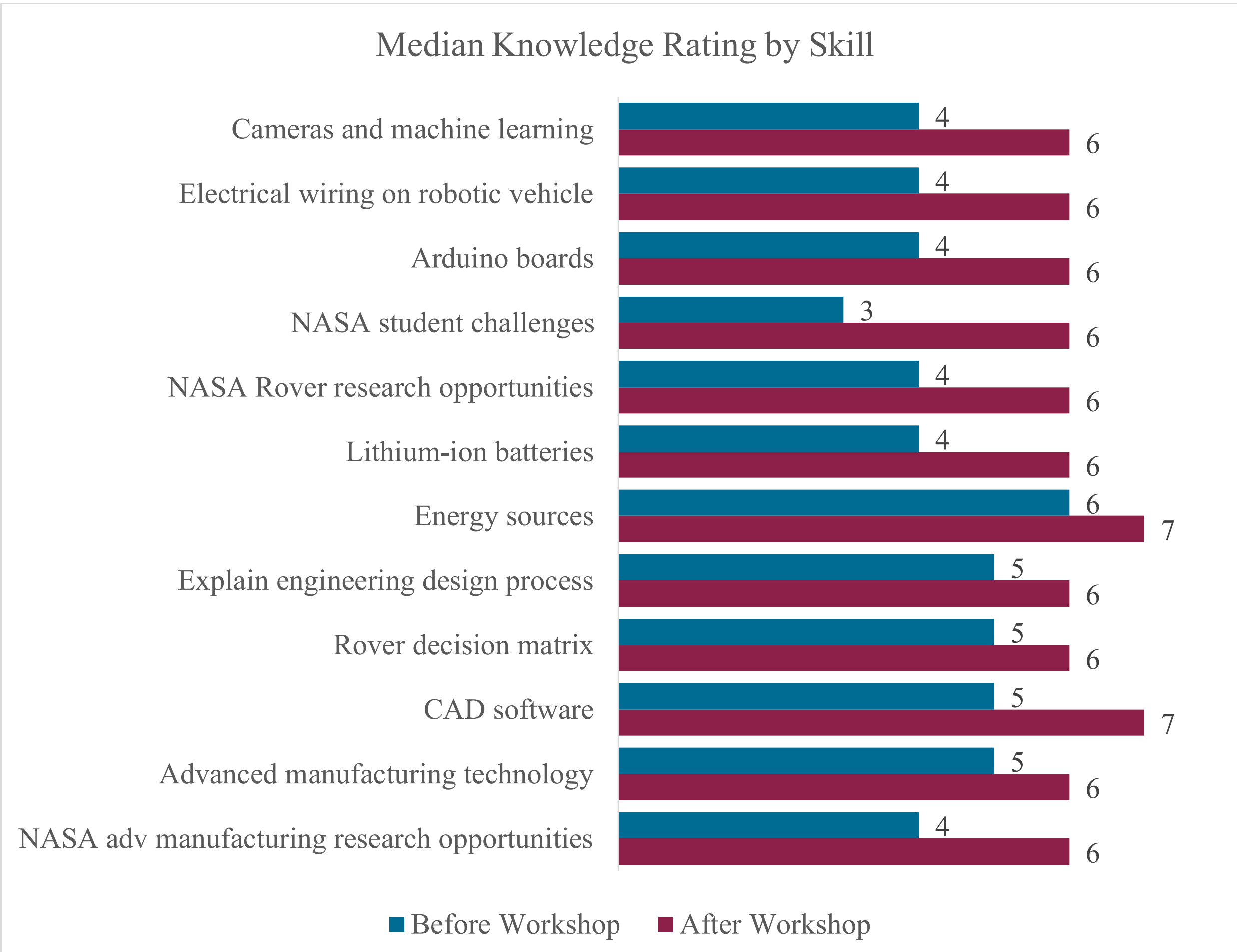

FIGURE 2. Median Knowledge Item Ratings

Students' ratings of interest in engaging in STEM opportunities at NASA were also significantly higher after the workshop as compared with before. Overall, the majority of students (38%) rated their interest higher after the workshop, 51% the same, and 11% rated interest lower. These differences are statistically significant ($Z=-3.254$, $p<.001$).

Discussion

The results of this study provide initial evidence that participation in the workshop was associated with increases in students' perceived knowledge of NASA opportunities and technical content areas. These findings are consistent with prior PCEE research, which has demonstrated that hands-on, experiential learning environments can enhance student engagement and perceived learning.

The workshop's integration of technical modules with explicit exposure to NASA pathways represents an important contribution relative to similar programs. While many PCEE initiatives focus on increasing general interest in STEM, this workshop emphasizes career awareness and pathway development, helping students connect technical skills to real-world opportunities such as NASA internships, competitions, and future employment. The university–school district partnership model also plays a critical role in expanding access. By leveraging institutional resources and existing student networks, the program reduces barriers to participation and provides students with exposure to university facilities and STEM professionals. This approach aligns with prior work highlighting the importance of partnerships in broadening participation in engineering

In conclusion, this workshop exemplifies an effective university-school district partnership model that successfully merges theoretical knowledge with practical, mission-driven application of the STEM workforce in NASA Artemis Mission. By engaging students in the complete engineering design cycle, from conceptualization and decision-matrix analysis to team-based prototyping and evaluation under real-world constraints, the program delivers authentic hands-on experience. Simultaneously, it strategically elevates student awareness of tangible pathways into the STEM workforce, specifically within NASA and the broader space sector, through direct exposure to Artemis mission case studies and guest experts. The initiative not only cultivates critical STEM technical and professional skills but also serves as a vital bridge, inspiring and preparing the next generation to pursue and seize opportunities in STEM [12].

In addition, an evaluation of a two-week NASA-focused STEM enrichment workshop designed to increase student awareness of engineering pathways and build foundational technical skills was presented. The results provide preliminary evidence of increased perceived knowledge and interest, while also highlighting the importance of integrating hands-on learning with explicit career pathway exposure.

Future Work

Future work will focus on strengthening assessment methods and expanding the program to broader student populations, contributing to ongoing efforts to build sustainable and inclusive STEM pipelines, preparing students for professional certificates or licenses such as Autodesk Credentials in 3D designing. Besides enriching the technical content of the workshop, the future evaluation would also include surveying a comparison group, who doesn't participate in the workshop, and using the comparison evaluation design to evaluate the effectiveness of the STEM workshop in preparing students for the future STEM workforce.

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