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1. Introduction

This report shows results from the developmental evaluation of phases B-D of the Lucy Student Pipeline Accelerator and Competency Enabler (L'SPACE) Program. The STEM Research Center at Oregon State University led an external evaluation for the program. This evaluation focuses on program development and success by analyzing student outcomes and feedback.

L'SPACE is the student collaboration portion of NASA SMD’s Lucy Mission which was launched to the Trojan Asteroids on October 16, 2021. This student collaboration differed from the traditional SMD student collaborations in that instead of having a small team of students build a payload experiment for a mission. This program builds foundational workforce development skills useful to NASA SMD’s mission focus. The L'SPACE Program is free and is supported by NASA subject matter experts (SMEs) who provide the interdisciplinary team-based training and professional preparation necessary for students to apply the discipline knowledge they have gained through their academic classes and apply that knowledge in a NASA-based project. The L'SPACE Program has three main goals:

1) Provide a deep SME-led NASA workforce development training with rigorous SMD-focused team projects at a national scale for undergraduate STEM majors.
2) Training has an inclusive focus on diverse and underserved/underrepresented students emphasizing critical industry-standard skill-building practices (e.g., working in teams, communication, collaboration, problem-solving, and critical thinking).
3) Provide an intensive, hands-on skill-building project for underserved students to build professional capabilities and STEM self-efficacy.

L'SPACE includes two 12-week academies: Mission Concept Academy (MCA) and the NASA Proposal Writing and Evaluation Experience (NPWEE) Academy. The program also supports summer internships with the Lucy Mission co-investigators and mentoring experiences, which are not the focus of this report. The Mission Concept Academy is a NASA Science Mission Directorate (SMD) focused, team-based solar system mission concept formulation and design project. In MCA, students learn the basics of teaming and communication and are tasked with designing a unique NASA solar system mission to fit within the designated requirements and destination given. The teams then mature their concept into an industry-standard professional Preliminary Design Review (PDR) level technical document for NASA review. 12 different SMEs instruct the students during this academy. The MCA team’s PDRs documents average 75-150+ pages in length. Professional feedback is provided to the teams on the aspects of their design and PDR technicalities, and teams are allowed to resubmit the updated content to professionalize their work.

The Space Technology Mission Directorate-funded NASA Proposal Writing and Evaluation Experience (NPWEE) Academy is an authentic proposal writing academy led by a NASA Center Chief Technologist and proposal expert. Participants respond to a solicitation created for use by NASA for the NPWEE Academy. The team’s proposal is submitted according to NASA guidelines and coupled with an authentic NASA review panel experience in which they are trained and serve as NASA reviewers to score the quality of the academy proposals. NASA
STMD invests $10,000 in the winning proposal idea as start-up funding to mature the idea. To date, NASA STMD has awarded funding to 17 teams.

2. Evaluation Methods
This evaluation aims to help the L'SPACE program optimize strategies and activities that contribute to the project’s success and provide initial evidence for program quality and success. The evaluation focuses on assessing how the program works toward achieving its goals. We designed the evaluation to focus on these student outcomes and provide useful feedback to the L'SPACE team to continue to improve the program.

Our evaluation questions focus on assessing whether, how, and to what degree the L'SPACE program reached its goals and focused on whether the program was beneficial to participating students. The overall evaluation goal is to Understand how the L'SPACE program supports the acquisition and transfer of skills to the workforce for all students.

To achieve this evaluation goal, we addressed the following questions and objectives;

1. To what degree does the program emphasize working in teams, communication, problem-solving, and critical thinking?
2. In what ways and to what degree do students who participate in the program benefit?
3. To what degree did the students feel the program was valuable overall, and what elements of the program contributed most to the student’s perceived value?
4. What challenges does the program face in reaching its goals?
5. How did the program respond to early feedback, and did changes lead to improved perceptions of value by students?

Our assessment of the program was informed by the experiential learning program literature, specifically on programs that seek to facilitate skill development and transfer into the workplace. Experiential learning is an applied learning approach in which students engage in professional, productive learning activities, thereby constructing knowledge and practicing skills (Council for the Advancement of Standards in Higher Education, 2009; National Society for Experiential Education, 1997). Experiential learning programs include (but are not limited to) internships, externships, practicums, student teaching, cooperative education programs, research experiences for undergraduate students (REU), and work-integrated learning programs. Universities, or facilities at universities, often offer these programs. These programs can also be associated with a national lab, a government agency, a corporation (as part of workplace learning), or a nonprofit organization.

Many of these programs aim to facilitate skill transfer, which is the ability of students to apply cognitive gains from one learning situation to another (Dori & Sasson 2013, NASEM 2018). Specifically, these programs aim to facilitate student skills transfer gained in an experiential learning setting to the workforce, referred to as graduate transfer (Leberman et al. 2016). There are examples of programs that facilitate long-term impact on the skill transfer of their participants. For instance, Bradberry and De Maio (2019) found that students in an experiential program reported being able to transfer the skills they learned to their current jobs. Mayorga (2019) found that students in an experiential learning program focused on business incubation...
could speak to their experience with specific essential skills by referring back to the program, which made them more competitive in the job market. Hart (2019) reviewed the education literature to assess how different types of project-based learning programs facilitate skill transfer and found that interdisciplinary programs were significantly associated with perceived gains in interdisciplinary effectiveness with communication and teamwork skills.

The transfer of skill is not entirely dependent on the program in which the student acquires the skill. It is also impacted by the learner’s characteristics and the characteristics of the new context within which they apply the skills. Jackson’s 2016 model of skill transfer postulates that various learner, program, and workplace characteristics impact skill transfer. The learner’s personality, motivation, and related experience are key characteristics that influence the transfer (Chiaburu and Marinova 2005; Jackson 2016). The learner’s workplace is also a factor. The culture of the workplace, peer support, supervisory support, and capacity or opportunity for transfers all impact degrees of transfer (Chiaburu and Marinova 2005; Jackson 2016).

We employ Jackson’s 2016 model of graduate transfers to inform how we characterize the L’SPACE program and the program’s characteristics and how they facilitate skills acquisition and transfer. L’SPACE employs many of Jackson’s program characteristics that encourage skill transfer but also fosters the development of learning characteristics and incorporates workplace characteristics.

Specifically, the L’SPACE program claims to have the following characteristics;

1. The similarity between learning and application contexts
2. Learner appreciation for skill relevance
3. Clearly defined learning goals and objectives for target skills
4. Collaborative engaged learning
5. Reflecting on target skills and strategies for development

Additionally, the program fosters learner characteristics, including motivation to learn and transfer abilities. The program also incorporates workplace characteristics of the potential employers of the students (NASA, SpaceX, etc.), including access to role models and coaching, a collaborative environment with peer support, group norms, and a culture that is open to innovation and change.

**Instruments**

To address our evaluation questions, we implemented a pre-post-survey design in the early parts of the program (and continued with a retrospective post-survey design in later phases), reviewed peer evaluation assessments, administered a survey of program alums, and conducted select course observations. The evaluation team also routinely held meetings with the L’SPACE program team to discuss preliminary evaluation findings and optimize the program.

The pre-post and Alumni survey provided the majority of evaluation data. In phases B and C, we implemented pre-post surveys. Pre-surveys were sent to all students in the program’s first week, and post-surveys were sent in the last week. We used pre-post surveys to compare students’ confidence in their STEM skills and career path plans from the beginning of the program to the
end. In phase D, we employed retrospective post-surveys to address potential survey fatigue. At the end of phase D, we also sent an alumni survey to all former participating students.

3. Results and Discussion

**EQ 1. To what degree does the program emphasize working in teams, communication, collaboration, problem-solving, and critical thinking?**

In the pre and post-surveys, students were asked to rate on a scale from 0-100 the degree to which they aligned with core skills related to the course: working in teams, written communication, problem-solving, and critical thinking. The survey questions included a mixture of positive and negative statements for each construct. As indicated by student self-assessment, the program’s key contribution was eliminating barriers to applying 21st Century skills rather than creating or strengthening existing ones. The program might have attracted a biased group of students who were positively inclined towards core skills and therefore experienced a ceiling effect when describing their comfort with those skills. Nonetheless, there is a strong indication that the program addressed perceived weaknesses in key skills.

Fostering good teamwork skills is a significant element of the program. Overall, students indicated that they feel many of the positive statements described them in both the pre and post-survey. Students gained confidence working in a team (17% fewer students felt insecure when working on a team post-survey). In phase D, we used the Wilder Collaboration Factors Inventory to further break down teamwork elements into five successful collaboration factors (Mattessich et al. 2001). These characteristics include; Communication, Membership Characteristics, Process and Structure, Purpose, and Resources. Table 1 shows that phase D students responded positively to all the characteristics.

*Table 1: Collaboration Characteristics (n=885). Students responded to a set of statements describing each characteristic of successful collaborations. They self-reporting on a scale of 0-100, 0 means the statement did not describe them, and 100 means the statement very much described them.*

<table>
<thead>
<tr>
<th>Collaboration characteristics</th>
<th>Description of the factors of these characteristics and how they can be measured.</th>
<th>Average % score of self-reporting of this characteristic.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Membership Characteristics</td>
<td>Team members share an understanding and respect for each other, including how they operate, their cultural norms and values, their limitations, and their expectations. members can compromise since many of the decisions within a collaborative effort cannot possibly fit the preferences of every member perfectly</td>
<td>81.23%</td>
</tr>
</tbody>
</table>
### Process and Structure
Members share a stake in both process and outcome. The group remains open to various ways of organizing and accomplishing its work—developing clear roles and policy guidelines. The group can sustain itself amid significant changes. 82.2%

### Communication
Open and frequent communication and establish formal and informal relationships and communication links. 86.5%

### Purpose
The goals and objectives of the team are clear to all partners and can realistically be attained. Team members have the same vision, with a clearly agreed-upon mission, objectives, and strategy. 86.24%

### Resources
The team allows sufficient time to achieve its goals and includes time to nurture collaboration. The individual who provides leadership for the group has organizing and interpersonal skills and fairly carries out the role. 92%

When comparing the data in phases B, C, and D, we see an overall increase in students indicating they had a positive team experience. In phase B, some students indicated that communication was a challenge in the team 24% of students felt communication was a challenge in phase B (n=242). Only 12% in both phases, C (n=859) and D (n=885), felt communication was challenging. The L'SPACE staff has taken action to facilitate better teamwork by using mentors and setting up a more systematic way of tackling these challenges. It is important to note that some team conflicts can be a good learning experience for the students. For future work on these issues, we will track what specific challenges they faced on their teams and what they did to overcome them.

In phases C and D, we added survey questions about the additional skills students are introduced to in the course, problem-solving, project management, written communication, and interdisciplinary work. There is a marked improvement in students’ confidence in these skills between pre and post-surveys in phases C and D. For each of these categories, the average response in the post-survey was 85 out of 100 on the confidence scale. On average, there is a 7-point increase from pre to post for these skills.

The Alumni survey focused on gathering evidence around a key claim of the program, namely that by design, it allows students to transfer course skills into the workplace or the next educational experience. Our evidence suggests that L'SPACE was highly successful in that regard: 88% of alumni respondents agreed that the experience they had working on a project team from L'SPACE was very helpful or even essential for their current position. In the alumni survey, we asked respondents to reflect on the skills they were taught in the program and how often they use those in their current positions. Table 2 shows the responses to this question from the alumni who have graduated with their 4-year degree and are working full time. Over 93% of these alumni use problem-solving, written and verbal communication, and technology
literacy daily. These alumni are not widely using skills such as project management, proposal writing, and team leadership. Since many of these alumni are early-career and have not been in their current position for more than a few years, these results are not surprising for this first check-in with the alumni. We expect the results to shift if we survey these alumni 3-5 years from now.

<table>
<thead>
<tr>
<th></th>
<th>I do not use this skill, or I use this skill rarely</th>
<th>I use this skill most days to every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Solving</td>
<td>7%</td>
<td>93%</td>
</tr>
<tr>
<td>Scientific reasoning</td>
<td>24%</td>
<td>76%</td>
</tr>
<tr>
<td>Technology literacy</td>
<td>7%</td>
<td>93%</td>
</tr>
<tr>
<td>Team Leadership</td>
<td>34%</td>
<td>66%</td>
</tr>
<tr>
<td>Project management</td>
<td>34%</td>
<td>66%</td>
</tr>
<tr>
<td>Proposal and technical writing</td>
<td>49%</td>
<td>51%</td>
</tr>
<tr>
<td>Written and verbal communication</td>
<td>4%</td>
<td>96%</td>
</tr>
</tbody>
</table>

Table 2: Alumni responses to the questions “Of all of the important skills needed in the workforce, which of the following are most important in your work now?”, n=67 (Graduated and employed full-time sub-group from the overall group of alumni who took the survey)

**EQ 2. In what ways and to what degree do students who participate in the program benefit?**

Who was attracted to the program, and did the rigorous and application-oriented, real-life professional context scare participants away from their chosen area of academic focus or confirm their choices? Note that this question is not trivial: introducing students to the complexity of a field or profession when they are not ready for it can have the opposite effect of what is often intended. Career “realism,” a sense of what a job truly entails and what it takes to get there, can become a barrier or repellent.
During Phase D, we added demographic and socioeconomic-related questions to the post-survey. Table 3 shows the results of these questions. The average age of students is 24, with many in the 20-23-year-old range. A majority (54%) of students identify as male. Many of the students identify as white/European (40%) or Latino, Hispanic, or Chicano (40%) (they were able to select multiple options for race/ethnicity). Over 44% of students reported that they are eligible for Pell grants of need to work to pay for college. This indicated that they are in a moderate to low socioeconomic situation.

Table 3: Demographics of students from Phase D Spring and Summer academies (n=221)

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>Race/ethnicity</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>33% are 20-23 years old</td>
<td>54% man</td>
<td>White/European 40%</td>
<td>● 16% of students identify as LGTBQ+</td>
</tr>
<tr>
<td>average age is 24</td>
<td>43% woman</td>
<td>Latino/Latina/Latinx and/or Hispanic, and/or Chicano 40%</td>
<td>● 44% eligible for Pell grants</td>
</tr>
<tr>
<td>oldest student is 47</td>
<td>2% Agender/Non-Binary/Third gender</td>
<td>29% Asian (8% East Asian, 10% Southeast Asian, and 11% South Asian)</td>
<td>● 45% need to work to pay for college</td>
</tr>
<tr>
<td>youngest is 19</td>
<td>1% prefer not to answer</td>
<td>7% black or African</td>
<td>● 18% are first-generation college students</td>
</tr>
</tbody>
</table>

We asked about the industry and field they planned to have a career in and if they wanted to do an internship for deeper exposure, and if so, exactly in what field. We asked these questions in the pre and post-surveys to assess if the students shifted their career plans after participating in the program or intended to continue on their path. We did not see any major changes in their career plans from pre to post (a highly positive result). Responses were fairly consistent year to year, allowing us to average responses across years for descriptive purposes. We found that 33% of students want to attend graduate school or stay in academia; 30% plan to work in government, and 29% plan to work in the private sector. 48% of students plan to work in engineering, 29% in scientific research, and the remaining 23% in other fields. 93% of students plan to do an internship, with nearly 50% planning to do one in engineering and 33% in scientific research. A majority of the students indicated they would like to do an internship at NASA or SpaceX. In summary, the program attracted a student body well aligned with the program goals (i.e., it reached its target audience), and despite its rigorous and applied approach, was able to retain and reinforce students' possible selves in NASA-related disciplines.

“...this program not only made me a better-thinking individual, but it opened my eyes to the wide range of possibilities I will have presented to me in the future. This program also gave me the
"motivation I need to get myself into the space industry, hopefully NASA. This program gave me insights I was looking for to advance myself in the technical world."

44% of respondents to the alumni survey are full-time students (n=435), and 18% are employed full-time. Because L’SACE is primarily a workforce development program, we will focus on the subset of respondents working full-time for this section.

Table 4: STEM fields of L’SACE alumni with full-time jobs.

<table>
<thead>
<tr>
<th>STEM Field</th>
<th>% of alumni</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>3%</td>
</tr>
<tr>
<td>Other-Engineering</td>
<td>7%</td>
</tr>
<tr>
<td>Chemistry/ Biochemistry</td>
<td>7%</td>
</tr>
<tr>
<td>Computer Science/ Information Technology</td>
<td>7%</td>
</tr>
<tr>
<td>Aerospace Engineering</td>
<td>7%</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>9%</td>
</tr>
<tr>
<td>Software Engineering</td>
<td>18%</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>31%</td>
</tr>
</tbody>
</table>

All demographic data of alumni who are working full-time match those of the students in the program, except for gender. Women make up 27% of this subset of the alumni, and men 69%, 80% of these alumni work in private industry, and 92% work in a STEM field. Of the STEM fields alumni work in, the majority, 90%, are in engineering, with many students in mechanical engineering positions (table 4). Of the alumni who have graduated with a 4-year degree and are working full-time, 56% have been in their jobs less than six months. 74% are on the career path they want to be on, and while they are satisfied with their current position, they are also looking to advance in the next few years.

**EQ 3. To what degree did the student feel the program was valuable overall, and what program characteristics contributed most to the student’s perceived value?**

The pre-post surveys in phases B and C asked students if they had reached their goals in the course, and in a subsequent open-ended question, they were asked to list their goals for the course. [Note that at this point of program development, it was not yet known how aligned program staff and students were around goals]. Responses to these open-ended questions in phases B and C were coded and informed the development of a new goals-related closed-ended question for the phase D surveys.
74% stated in phase B (n=1287) that they fully reached their goals, a number that increased by 12% in phase C after program modifications were made (n=859) (see below). Overall, 98% of students stated in phase C that they either partially or fully reached their goals for the program, an astoundingly high number for any program of any type.

From the open-ended responses to the goals question in phases B and C, we formed a list of students' common goals for the course and worked with the L'SPACE team to refine this list based on the desired student outcomes. These goals are to enhance teamwork skills, gain transferable experience and knowledge, gain experience in NASA mission operations, gain experience in the aerospace field, improve technical skills, improve leadership skills, gain experience in research, and gain experience in scientific writing.

In phase D, post-survey, students were asked to indicate if they felt they reached each of these goals (I reached this goal, I partially reached this goal, and this was not a goal of mine). There was also a space for students to fill in other goals for the course. Most students (91%) indicated that they partially reached or reached these goals.

In phase C, we focused on understanding the motivation for why students took the course (see table 5). Key motivators for engagement with the course were career-related and focused on NASA content and careers.

<table>
<thead>
<tr>
<th>Reason for taking the course</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can't find a course like this at my college or university</td>
<td>35%</td>
</tr>
<tr>
<td>It fits well with my schedule</td>
<td>31%</td>
</tr>
<tr>
<td>It is free</td>
<td>50%</td>
</tr>
<tr>
<td>I am interested in NASA Science</td>
<td>93%</td>
</tr>
<tr>
<td>It will benefit me in my future career</td>
<td>91%</td>
</tr>
<tr>
<td>It will help me when applying for internships</td>
<td>79%</td>
</tr>
<tr>
<td>I can participate remotely</td>
<td>55%</td>
</tr>
</tbody>
</table>

Table 5: Student reasons for taking the course (percentage of students - multiple responses possible) (n=2839)

In phases C and D, we also asked about the most exciting course elements. In phase C, this was asked in the pre-survey. Students were most excited about working on real-world projects (83%) and interacting with NASA scientists (86%) (n=859). Initially, they were least excited about learning more about the Lucy mission (16%). The phase D post-student survey found the same things as exciting, interacting with NASA scientists and working on a real-world project (n=885)

In the alumni survey, we asked former students to indicate how the L'SPACE program helped prepare them for their career path, 88% said that L'SPACE helped empower them to think they could have a career in aerospace, (93% felt empowered to have a career in STEM), 90% felt the program helped them understand what the STEM workforce is like, and 94% felt the
program helped hone skills that are transferable and applicable. 95% of alumni would recommend this program to others,

“Having to work in teams remotely definitely helped me level up my communications skills since it was necessary to be able to perform well. Additionally, listening to weekly speakers and their journeys into the workforce also helped me understand how common imposter syndrome is and also, how achievable dreams are to those who work hard.”

“It has sharpened my leadership skills, has allowed me to network with experts in various fields, as well as network with a lot of people interested in aerospace who all share their perspectives, information, and resources which helps us grow together as a community. It is like a beautiful family, and staying in-network alone has helped me chisel out my skills for relevant internships. It also helped me get my first paid position as a data analysis research intern…”

The alumni were asked to reflect on the program and indicate how it helped them on their career pathway. Table 6 shows the results from a Likert scale question that asked students to respond to statements about the program providing career support, promoting self-efficacy, and skill building. Of the alumni who have graduated and worked full time, the majority agree that the program provided them with career support by helping them understand what a career in aerospace/STEM entails and the different positions available. Most alumni also felt the program helped them be empowered to have a job in aerospace/STEM and have confidence in their skills and abilities. They also indicated that the program helped them build their skills.

<table>
<thead>
<tr>
<th>L’SPACE helped me….</th>
<th>Disagree</th>
<th>Neither agree or disagree</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Career Support</td>
<td>5</td>
<td>8</td>
<td>58</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>4</td>
<td>7</td>
<td>63</td>
</tr>
<tr>
<td>Skill building</td>
<td>2</td>
<td>7</td>
<td>64</td>
</tr>
</tbody>
</table>

Table 6: Alumni perceptions of the benefit of the L’SPACE program N=72 (a subset of alumni survey responses of just people who have full-time jobs). Results are shown as a raw count.

**EQ 4. What challenges does the program face in reaching its goals?**

Over the last three years, the program staff has adapted and refined the program based on student feedback. For example, 30% of students in phase B felt the guest speakers did not speak on topics relevant to the course. In phase C, 98% felt the guest speaker did speak on topics pertinent to the course. (The speakers were the same in phases B and C, but the team gave more context to why the speakers were invited. Additionally, in phases B and C, students
were asked about the instruction and logistics of the program. In phase B, 30% of students indicated that the staff could have done more to support them. In phase C, 91% of students said that the staff provided the support they needed (mentors were added during phase C).

“ I loved the weekly speakers. Sheri and Dann were so supportive and inspirational. It was great to have a weekly reminder about what I’m working for and seeing people who are doing what I want to do as a career.” - A student from year 2

A perpetual challenge for a program that is heavily centered on teamwork is team dynamics and resolving conflict in teams. The students come from an array of educational and personal backgrounds. Some students from a science background placed on teams with engineers felt shut down during discussion-making. One particular student said, “Really my team just didn't make me feel heard because they weren’t listening. I don’t know if it’s because I’m a girl but the other girl on our team felt the same way. The program itself is not at fault, but maybe keep an eye out to prevent other future female scientists and engineers from feeling the same way.”

Another student has a suggestion for the program on how to mitigate team conflict issues, “I think a team bonding activity that is a more direct assignment, other than just to have a meeting together, would have built a greater sense of comradery early on. I would suggest to have this the second week of team assignment with questions such as what is “team member's” favorite type of music, food, etc”

<table>
<thead>
<tr>
<th>Challenges Due to the Pandemic</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faced challenges finding work in your preferred field</td>
<td>244</td>
<td>175</td>
</tr>
<tr>
<td>Faced challenges in attending online classes</td>
<td>188</td>
<td>231</td>
</tr>
<tr>
<td>Experienced impacts on my mental health</td>
<td>160</td>
<td>258</td>
</tr>
<tr>
<td>Decided to take a break from school or work to care for a child or relative</td>
<td>385</td>
<td>33</td>
</tr>
<tr>
<td>Decided to take a break from school or work due to mental health</td>
<td>359</td>
<td>58</td>
</tr>
<tr>
<td>Decided not to apply or attend graduate school</td>
<td>369</td>
<td>49</td>
</tr>
<tr>
<td>Experienced impacts on my physical health</td>
<td>255</td>
<td>164</td>
</tr>
</tbody>
</table>
The COVID-19 pandemic had the potential to create major challenges for the program and its students. Fortunately, due to the program’s nature as a virtual experience the program has some built-in resiliency to the pandemic. To understand the effect the pandemic had on the program alumni, we asked the alumni survey respondents to respond to statement about the pandemic’s effect on their lives and career paths (Table 7)

**EQ 5. How did the program respond to early feedback, and did changes lead to improved perceptions of value by students?**

One focus of the evaluation team has been to figure out the LSPACE “secret sauce,” e.g., the elements of the program that have contributed to its success. The LSPACE staff and leadership are key to the program’s success. The responsiveness and flexibility of the staff and leadership have allowed the program to thrive during the COVID-19 pandemic. The staff and leadership have also supported the cultivation of the L’Fam, which in the surveys is referred to by many students. In the alumni survey, we asked how the staff/leadership of the program was impactful, 96% said they felt the staff treated them with respect, 89% said the staff showed concern, 86% said the staff helped minimize anxieties about the program, 93% said the staff had constructive feedback, 89% said the staff was available as needed.

“No other program has changed my life to such a degree. Everyone I have met has been just truly wonderful and a blessing to be involved with. I really cannot stress how much this program has saved me in light of the pandemic. I would be very lost without my L'Space experiences and no where near the trajectory I am currently on. It prepared me for the workforce, it introduced me to other wonderful peers, it networked me with career professionals, and most importantly it gave me confidence that I can actually be involved and make a difference in the effort of space exploration. So yes, if my classmate is interested in any of the above (or would even care to listen!) I would happily recommend L'Space to them.”

**4. Conclusion**

Overall the LSPACE program is reaching its goals and consistently iterating on and improving the program. Students feel the program is beneficial to their future and a worthwhile experience. We encourage the LSPACE team to continue to refine how they handle team dynamics and continue to encourage students to be welcoming and cooperative in their teams. The LSPACE team should continue checking in with teams about conflicts and create a welcoming space for students to express their concerns with their teams. Another issue is team composition. There can be challenges for some who find themselves in the minority. The LSPACE team has refined how they select the teams, and we encourage them to continue to refine and improve this process. Although few students expressed issues with their teams, this can significantly impact their experience. We also encourage the team to continue to be honest with students about the nature of the academy and why the skills (teamwork etc.) are just as important as the technical skills. The NASA brand is a major draw for the students. We encourage the team to continue to lean into the NASA brand. In future evaluation activities, we plan to focus on the longitudinal collection of data to assess the impact of the program on students’ careers
The course elements that students call out as being impactful in their skill development and transfer are reflective of those in Jackson’s model of skill transfer. This includes the similarity between learning and application contexts and learner appreciation for skill relevance. The connection between the program and NASA is key to connecting the skill they are learning to real applications and the guest speakers sharing how they work and use those skills regularly. This connection between the skills and workplace applications and context also helps the students understand the learning goals and objectives for the skills. The students also acknowledge that they practiced the skills and achieved objectives through collaborative work in their teams.

**Future Evaluation Plans**

Phase E of the LSPACE program will be evaluated by Drs. Martin Storkdieck and Heather Fischer of Oregon State University’s STEM Research Center (SRC). The OSU SRC team will include the support of a Ph.D. student intern from OSU’s College of Education during the summer of 2022 and 2023. The evaluation of phase E will focus on two evaluation objectives:

1. support continued project implementation and allow for evidence-based improvements to design and application, and  
2. Assess how and to what degree the project has achieved its goals of workforce preparedness, mainly the acquisition and transfer of essential skills to the workforce.

This work will be done in two phases: continued developmental evaluation in 2021-2025 (with increasing the outcome and impact focus over time) and summative (outcome and impact-focused) evaluation in 2026. Specific details of the phase E evaluation are detailed in the Phase E Evaluation plan (see supplemental materials).

**5. Evaluation Team**

Oregon State University’s STEM Research Center (SRC) led the evaluation of this project, and Dr. Martin Storkdieck will serve as the lead evaluator of the project and provide guidance on the overall project, including research design and methodology; he is a informal STEM education and science engagement research expert. Dr. Storkdieck is the director of the SRC and a professor in OSU’s College of Education. Dr. Heather Fischer supported the evaluation. Fischer is a Senior Researcher at the SRC, where she serves as a researcher and evaluator on a variety of projects related to transfer around professional learning, including the IMPEL project and a Phase 1 NSF Convergence Accelerator project that focused on identifying and supporting pathways into “safer” careers by identifying and enhancing transferable professional skills. She also is an affiliate faculty in the Environmental Science Program at OSU.

**6. References**


https://books.google.com/books?hl=en&lr=&id=z7CXCwAAQBAJ&oi=fnd&pg=PP1&ots=v5D-oSEI8d&sig=un2DYexveZjN85y5qj7BVokub0


Start of Block: Student Information

Your Name

☐ First ______________________________

☐ Last ______________________________

What is your L'SPACE User ID (UID) number? To locate your UID, please visit <a href="https://lspace-applications.asu.edu/user">https://lspace-applications.asu.edu/user</a> and log into your L'SPACE account.

________________________________________________________________

What is your L'SPACE username?

________________________________________________________________

Email

________________________________________________________________

Which academy were you enrolled in this term?

☐ Mission Concept Academy (MCA)

☐ NASA Proposal Writing and Evaluation Experience (NPWEE)

End of Block: Student Information
Start of Block: MCA Module Feedback

Which modules did you complete?

☐ Teaming
☐ Requirements
☐ Risks
☐ Project Management
☐ Systems
☐ Heat Transfer
☐ NX

Which module did you find the most useful and why? <br>
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________

Please provide details as to how we can improve the course content
________________________________________________________________
________________________________________________________________
________________________________________________________________
End of Block: MCA Module Feedback

Start of Block: Class Perceptions

Why did you choose to participate in the L'SPACE program? (select all that apply)

☐ A mentor or professor encouraged me to apply
☐ It is a potential path to an internship
☐ I wanted to engage with NASA scientists and science
☐ Gain relevant skills for future career
☐ Networking
☐ I participated in another L'SPACE opportunity
☐ The program fits my schedule
☐ The program is not competitive
☐ The program does not have a GPA requirement
☐ Other

__________________________________________________________________________
What excited you most during the academy?

<table>
<thead>
<tr>
<th>Event</th>
<th>Not exciting at all</th>
<th>Slightly exciting</th>
<th>Moderately exciting</th>
<th>Very exciting</th>
<th>Extremely exciting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guest Speakers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interacting with other students</td>
<td></td>
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<tr>
<td>Collaborating with a team</td>
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<tr>
<td>The team project</td>
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</tr>
<tr>
<td>Working on a &quot;real world&quot; project</td>
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<tr>
<td>Working in a &quot;real world&quot; environment</td>
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<tr>
<td>Learn more about the Lucy Mission</td>
<td></td>
<td></td>
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<tr>
<td>Networking opportunities</td>
<td></td>
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<tr>
<td>Interact with Scientists</td>
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</tr>
<tr>
<td>Learn more about aerospace engineering</td>
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<tr>
<td>Learn more about NASA</td>
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</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Did you reach your goals for the academy? Please react to the following statements.

<table>
<thead>
<tr>
<th>Goal</th>
<th>This was not a goal of mine</th>
<th>I did not reach this goal</th>
<th>I partially reached this goal</th>
<th>I reached this goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhance my teamwork skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain transferable skills and knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain experience in NASA mission operations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain experience in aerospace field</td>
<td></td>
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<tr>
<td>Improve my technical skills</td>
<td></td>
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<tr>
<td>Improve my leadership skills</td>
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<tr>
<td>Gain experience in research</td>
<td></td>
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<tr>
<td>Gain experience in scientific writing (including writing proposals and reports)</td>
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</tr>
<tr>
<td>Connect with other students</td>
<td></td>
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</tr>
<tr>
<td>Learn more about working in the aerospace industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learn more about working at NASA</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Did you have any other goals for the program?

- [ ] Yes
- [ ] No

What were your other goals and did you reach them?

________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________

Did you ever feel like dropping out of the program?

- [ ] Yes
- [ ] No

Why did you consider dropping out of the program? and what (if at all) helped you continue? <br>

________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
Please react to the following statements about the L'SPACE program mentors.

<table>
<thead>
<tr>
<th>The mentors were available when I needed them</th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The mentors provided constructive feedback</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The mentors helped minimize my anxieties about the program</td>
<td></td>
<td></td>
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<tr>
<td>The mentors showed genuine concern for me and my well being</td>
<td></td>
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<tr>
<td>The mentors treated me with respect</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

End of Block: Class Perceptions

Start of Block: Skills Questions...

This course involved considerable team work, please reflect on your experience with your team. On a scale of 0 to 100 please rate how you think the following statements describe you

<table>
<thead>
<tr>
<th>Does not Describe Me</th>
<th>Somewhat Describes Me</th>
<th>Very Much Describes Me</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 10 20 30 40 50 60 70 80 90 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statement</td>
<td>Scale</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>When working in a team I listen openly to other team members</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I make team meetings and team work a priority</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am respectful of the team leader(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I ask my team mates questions if I am unclear about the team's goals or plans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If I do not agree with the team plans I communicate my feelings constructively</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When working in a team I feel I can propose new ideas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel comfortable asking my team members for help with my work</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please respond to the statements about projects below.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Describes me</th>
<th>Somewhat describes me</th>
<th>Very much describes me</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can analyze data for patterns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am able to figure out the next step in a project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am good at problem solving</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am able to write project proposals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am able to write project reports and papers</td>
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</tbody>
</table>

We are continually seeking to improve the program, do you have any other comments on your experiences in the program this year.

______________________________________________________________________

______________________________________________________________________
End of Block: Skills Questions...

Start of Block: Future plans

What are your plans after you finish your current degree? (Select all that apply)

- Work
- Do an internship
- Attend vocational training
- Attend community college
- Attend 4-year college or university for undergraduate studies
- Attend 4-year college or university for graduate studies
- Other ____________________________

What are your future career plans?

- Work in Academia
- Work in Government
- Work at non-profit
- Private Sector
- Not sure/Other ____________________________
What field do you see yourself working in?

- Engineering
- Scientific Research
- Mission Operations
- Data Analysis
- Other ____________________________________________

End of Block: Future plans

Start of Block: Demographic information

Thank you for taking the time to respond to this survey. This is the last section of questions. These questions focus on your personal background which helps NASA understand who we are reaching in our quest to reach a diverse workforce and provide inclusive experiences.

* What year were you born? (YYYY) 

___________________________________________
How do you identify?

- Woman
- Man
- Agender/Non-Binary/Third gender
- Self-describe __________________________________________________
- Prefer not to answer

Do you identify as LGBTQ+

- No
- Yes
- Prefer not to answer

When you were/are attending college/university, were/are you eligible for Pell Grants?

- No
- Yes
- Not sure
- Prefer not to answer
When you were/are attending college/university, did/do you work at a job for at least part of the time you were attending?

- Yes, I needed it to help pay for college tuition/expenses
- Yes, but I didn't need it to help pay for college tuition/expenses
- No, but I needed a job to help pay for college tuition/expenses
- No, and I didn't need a job to help pay for college tuition/expenses
- Prefer not to answer

What is the highest education level achieved by your parents/legal guardians?

- No formal schooling
- Less than high school
- Some high school
- High school diploma
- Some college
- 2-year college degree
- 4-year college degree
- Some graduate school
- Graduate degree
- I do not know
- Prefer not to answer
How do you identify? (select all that apply)

☐ Native American/Indigenous/First Nations

☐ White/European

☐ Black or African

☐ East Asian

☐ Southeast Asian

☐ South Asian

☐ Arab or Middle Eastern

☐ Native Hawaiian/Pacific Islander

☐ Native American/Alaska Native/Indigenous to North America

☐ Latino/Latina/Latinx

☐ Chicano/Chicana/Chicanx

☐ Hispanic

☐ Self-identify __________________________________________________

☐ Prefer not to answer

End of Block: Demographic information