Student-centered success: Exploring student-led recruitment in an aerospace undergraduate research program

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1   Introduction

Undergraduate research experiences (UREs) are an important opportunity for engineering students to develop critical thinking, innovation, and research skills. While many studies have focused on exploring UREs' impact on students' technical skills, there is limited understanding of their ability to develop some professional skills. One particularly understudied space is the impact of the students' participation in the recruitment process for new undergraduate researchers. Following the design of a student-let URE, this study used the tenets of Expectancy-Value Theory to understand the perception of the recruitment process from the applicants and the recruiters. Therefore, the primary objective of this work is to explore how different activities of the recruitment process are perceived by students in terms of importance, value, cost, and expectation for success. By understanding these perceptions, suggestions can be made to better support both the applicants and the recruiters during this process. Moreover, this work provides a novel perspective for the recruitment process for UREs that allows students to develop new professional skills.

2   Background

2.1   A Student-Led Undergraduate Research Program

The English-to-Engineering (E2E) program at Virginia Tech is an undergraduate research program designed to address critical gaps in student preparation as noted by Pratt & Whitney and by faculty leading the research experience. The program aims to cultivate research, critical thinking, and teamwork skills by immersing students in real-world challenges related to sustainable aviation. Developed through a collaboration with a senior technical fellow at the industry partner organization, this initiative aligns with the broader benefits reported in the literature for UREs.

Unlike traditional UREs, this program integrates multiple high-impact practices that enhance student engagement, learning outcomes, and career preparedness. These practices include:

- **Industry Sponsorship and Mentorship**: Students in the program benefit from direct collaboration with industry sponsors and mentors [1]. Students have aligned their projects with industry needs and priorities, providing students with the opportunity to work on critical, real-world problems. The program encourages the development of professional networks, enhancing students' collaboration and communication skills.

- **Vertically Integrated Projects**: Projects within the program span multiple years. This extended timeline enables students to develop deep expertise within their project domains while providing an organic necessity for recruitment, onboarding, and peer mentorship

[2]. Vertically integrated projects require continuity and knowledge transfer between cohorts to ensure project sustainment.

- **Early Academic Career Intervention**: The program is open to students across all undergraduate academic years. Teams often consist of senior students working alongside first-year students, creating opportunities for peer mentorship. This approach supports skill development for early academic career students and provides leadership opportunities for upper-level students [3].

- **Interdisciplinary Teams**: Another of the distinguishing features of the program is its interdisciplinary structure. Students from all majors across the university are encouraged to participate based on their interests in different aspects of research projects rather than their pre-existing knowledge. This inclusion allows students from any discipline to contribute to common technical goals in a space that at first blush would appear reserved for aerospace engineering [4].

- **Project-Based Learning**: The program is grounded in project-based learning with student teams engaging in real and relevant industry challenges. Students conduct all aspects of research, including literature reviews, experimental design, data collection, analysis, and reporting.

- **Student Agency and Leadership**: A key difference of the program is its emphasis on student agency. Unlike traditional UREs, where faculty act as principal investigators (PIs), the program positions students as project leaders. Faculty mentors and industry experts act rather as coaches, supporting student decision-making and project management.

The E2E program began in Fall 2021 with a call for proposals sent out to the general student body. This call was distributed largely through academic advisors, college- and departmental-level listservs, and announced in classes led by the founding faculty. From the initial set of proposals, five projects were selected, and a first cohort of ten students was invited to participate in the program.

Since its inception, the program has served over 57 students from eight different majors across the university. The current enrollment stands at 36 students. Notably, the acceptance rate for the past two recruitment cycles has been below 25%, demonstrating the competitive nature of the program. Additionally, the program boasts a student retention rate of over 90% year-on-year, reflecting the value students place on their experience within the program.

2.2 Student-Led Recruitment Process

A unique aspect of the E2E program is its student-led recruitment process. Returning students manage and direct recruitment each year. The process occurs during the early fall semester and begins with distributing marketing materials through various channels to direct interested

students to join a listserv. In early fall, returning students host an information session for prospective applicants. Invitations to apply are then sent to all students on the listserv, whether they attended the information session or not. The returning students develop the overall recruiting timeline, plan and conduct the information session, design the application screening rubric, develop interview protocols, conduct interviews, and make final recommendations for new recruits to faculty leadership.

Once new students are accepted into the program, returning team members actively onboard them. This onboarding process includes orienting new students to the program's goals, their specific project responsibilities, and the broader culture of the group. Returning students provide mentorship, ensuring that new recruits integrate smoothly into their teams and feel prepared to contribute to the goals of research projects.

While the literature discusses student-directed team formation in project-based learning, relatively little attention has been given to student-led recruitment in application-based programs.

2.3   Expectancy-Value Theory of Motivation

Table I: Concepts of EVT with definition and sample survey items.

EVT concept	Definition	Sample Item for Applicants	Sample Item for Recruiters
Self-Efficacy	A student's perception of their competence participating in the recruitment process	I am confident at presenting myself through a resume.	I can effectively develop a recruiting timeline.
Expectancy for Success	A student's expectation that they can achieve their goal in the recruitment process.	Based on my statement of interest, I am likely to move forward to the next recruitment stage.	Based on my abilities to screen applicants, I am likely to find good candidates for undergraduate research.
Task Value	A student's perception of the value of participating in the recruitment process.	Having good research proposal writing skills is important when applying to undergraduate research opportunities.	Being able to interview applicants is important for undergraduate research
Task Cost	A student's anticipated effort required to participate in the recruitment process.	Preparing for an interview takes up too much effort.	Organizing info sessions takes up too much time.

Developed by Eccles and her colleagues, expectancy-value theory (EVT) posits that individuals' motivation to perform a task is influenced by their expectation of success in the task and the

value they place on the completion of the task [5]. Several studies have demonstrated the suitability of using EVT as a framework to explore the motivation and decision-making of engineering students. For example, [6] and [7] used EVT as a guiding theory to explore why students choose to pursue engineering. Other studies like [8] leveraged the tenets of EVT to understand what motivates students to persevere in engineering school. This study used the EVT concepts to design survey questions that mapped directly to the students' perceived self-efficacy, expectancy for success, and cost of participation. The EVT concepts, definitions, and sample items focused on the context of this study are presented in Table I.

3   Methods

The purpose of this paper is to explore how students value the different aspects of recruitment via the lens of motivation theory. This study aims to understand how different activities throughout the recruitment process are perceived by students in terms of importance, value, cost, and expectation for success. Moreover, since the recruitment process is fully student-led, the perspectives of both applicants and recruiters are considered in this paper.

3.1   Participants

The participants for this study were recruited based on their participation in the recruitment process for the E2E program and chosen via purposeful sampling. Purposeful sampling focuses on selecting individuals that are critical for understanding the experiences that the study was designed around [9], [10]. In this case, the goal of the study is to explore the experiences of students participating in the recruitment process for this program. Therefore, the eligibility criteria included students applying to the program, as well as students organizing the recruitment activities. Since the application process was divided into two phases, the students applying to the program were invited to participate in the study twice, once per phase. The study's recruitment yielded the following participant groups: 21 students applying to the program during phase one, 19 students applying to the program during phase two, and 9 students who are part of the program and working on recruitment. All data collected was fully anonymous and institutional review board (IRB) approval was obtained to perform the study.

3.2   Data Collection and Analysis

Data were collected through 3 separate surveys. The primary purpose of these surveys was to understand the students' perceived cost, value, and self-efficacy of participating in the recruitment activities for the undergraduate research program. As such, the questions present in the surveys were adapted from data collection instruments in other EVT studies [11], [12]. Since the studies referenced did not focus on student participation in UREs, the exact wording of the items could not be retained. Each aspect of EVT was represented by at least one item, except for the self-efficacy of attending an information session which was not included. Participants rated their agreement to each item statement using a 5-point Likert scale ranging from 'strongly disagree – 1' to 'strongly agree – 5'. In addition, the final section of the survey asked students to

rank the activities they'd been surveyed about from easiest to hardest, most useful to least useful, and most important to least important. These questions were included as a survey reliability check as well as to ensure the internal consistency of the study.

All surveys were administered online and sent to the students via e-mail. The first survey was administered to all students who submitted an application. The survey was timed to be distributed after students had submitted their application packets, but before recruiting students notified potential candidates of a zoom interview request – that is, prior to any notification of advancing in the process after application. Survey 1 was designed to probe the perceived cost, value, and student efficacy with attending an information session, submitting a resume, developing an interest statement, and proposing a new direction of research for one of the topic projects.

The second survey was administered to those students selected for an interview, but before notification of invitation to the program. As these students were already surveyed on their perceptions of the initial portion of the recruitment process, Survey II was aimed at collecting student perceptions of the interview process.

The final survey was administered to all students in the research program, regardless of whether they had participated directly in the recruitment process as members of the student recruitment committee. Survey III gathered input from students in the program as to their perceptions of all elements of organizing and administering the recruitment process.

3.3   Limitations

There are certain limitations that arose during the design of this study. Participant bias occurs when the participants of a study disproportionally possess traits that might skew the data collected [13]. Since all the participants are either applying or already part of this URE, we expect that they are all highly motivated to participate in this program compared to students that have not applied. The goal of this study is to understand what parts of the recruitment process are valued by students, not to compare the results between the motivated and unmotivated students; therefore, participant bias is not a concern at the moment.

Another possible limitation is the sample size of the participants. Based on the purposeful sampling method, all applicants and all current members of the program were invited to participate in the study. In total, 42% of all applicants responded to Survey I, 55% of all interviewed students responded to Survey II, and 37% of program members responded to Survey III. While these response rates allow us to generalize our results to the current population, they might not be enough to imply transferability to other URE recruitment processes.

4   Results

4.1   Applicant Results

The first block of questions in the survey interrogated applicants as to their perceptions of the efficacy, value, and cost of the information session. Students in the program developed and administered an information session on a weekday evening to provide an overview of the program, a technical introduction to each of the 5 projects, and to provide a forum for questions from applicants about the program or the application process. The survey questions and results pertaining to the information session are shown in Figure 1.

Of the applicants who attending the information session, the majority indicated a low perceived cost of the information session with 64% of students indicating disagree or strongly disagree that the information session required compromise in doing other things or from doing their schoolwork. The applicants also perceived a high value in the information session, with all indicating that they acquired new information at the session, and 91% agreeing or strongly agreeing that the info session bolstered their confidence in applying to the program.
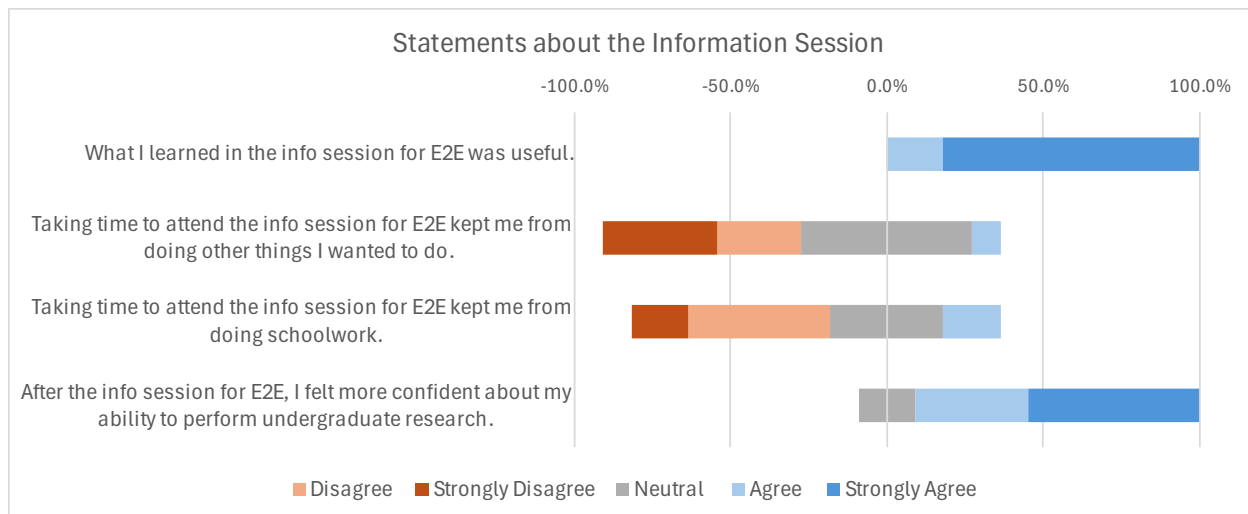

Figure 1: Applicants' perceptions of attending an information session

As shown in Figure 2, applicants also noted quite high value associated with the development of resumes, with all applicants agreeing or strongly agreeing that good resume writing skills are important for undergraduate research. We see overall high efficacy with resume writing skills, with 86% of students expressing confidence in their ability to represent themselves in a resume, and 71% indicating that the quality of their resume was likely to enable them to proceed to the interview process of the application process. Applicants generally indicated a low cost to producing a resume, with 67% noting that developing a resume did not take too much time.
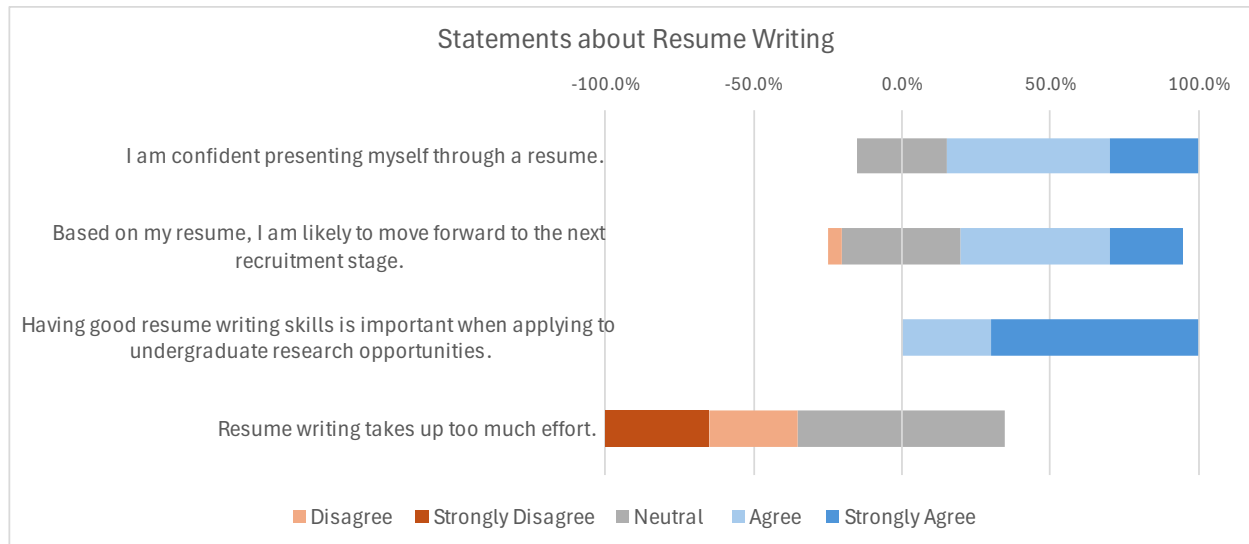
Figure 2: Applicants' perceptions of writing a resume

When asked about developing an interest statement or cover letter, applicants indicated both high value and high efficacy, as shown in Figure 3. All applicants noted that the ability to write an interest statement is valuable. While efficacy scores showed that 9.5% of students were neutral with respect to their efficacy in drafting an interest statement, nearly all students expressed confidence in their ability to draft the statement. We see that more students strongly agree that their interest statement will carry them forward than their resume (90% for interest statement vs 79% for resumes). Students indicated a slightly higher cost to develop the interest statement versus the resume.
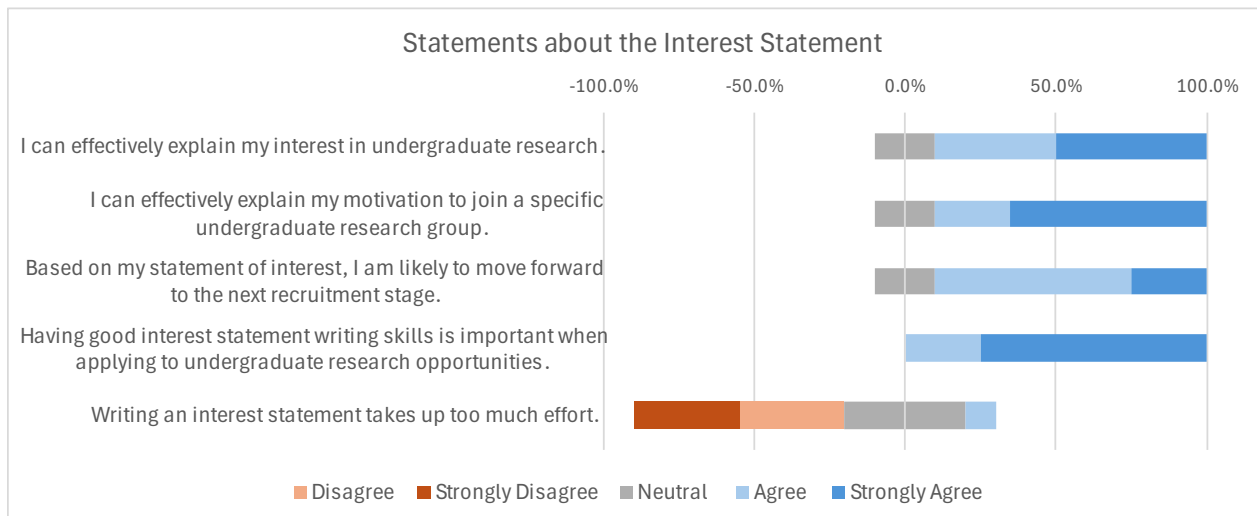

Figure 3: Applicants' perceptions of writing an interest statement

Applicants reported a slightly lowered perceived value of the research expansion component of the process. As seen in Figure 4, while the vast majority indicated that this was important, a 5% count disagreed with the value, and no students were neutral on the subject. Quite differently

from the resume or interest statement responses, applicants expressed far less self-efficacy with respect to their ability to compose a research proposal of sufficient quality to carry them forward in the recruitment process. Only 52% of the applicants agreed or strongly agreed that they could draft a quality research expansion topic. Applicants also noted a similar cost for developing a research proposal as for a resume in terms of total disagree/strongly disagree scores, albeit there was a slight indication of more cost for the research proposal in terms of strong disagreement that the cost was high (38.1% for resume vs 19% for research proposal).
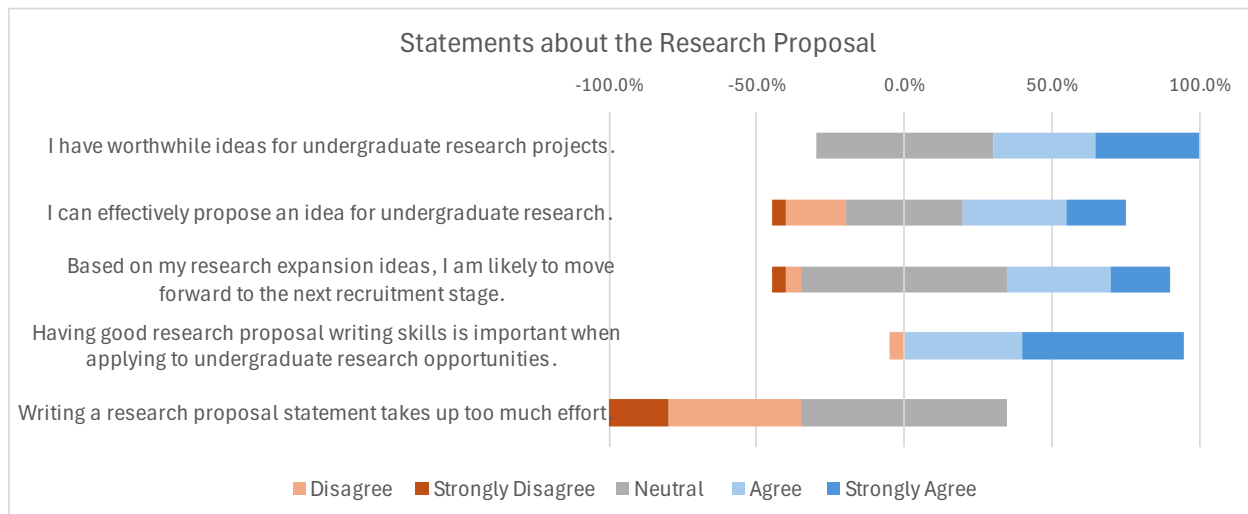

Figure 4: Applicants' perceptions of writing a research expansion proposal

Finally, the students who moved to phase II of the recruitment process answered questions about their participation in interviews. The results for these questions are shown in Figure 5. Students' perceptions of the interview process were quite clear in terms of value and cost. All interviewed applicants perceive the interview process as important and noted that it was worth the time required. Moreover, most of the participants had positive perceptions of their self-efficacy and expectancy for success, but they were not as confident as they were with other items like resume writing. This was particularly apparent in terms of expectancy for success as no student strongly agreed that they would advance to an acceptance letter after their interview.
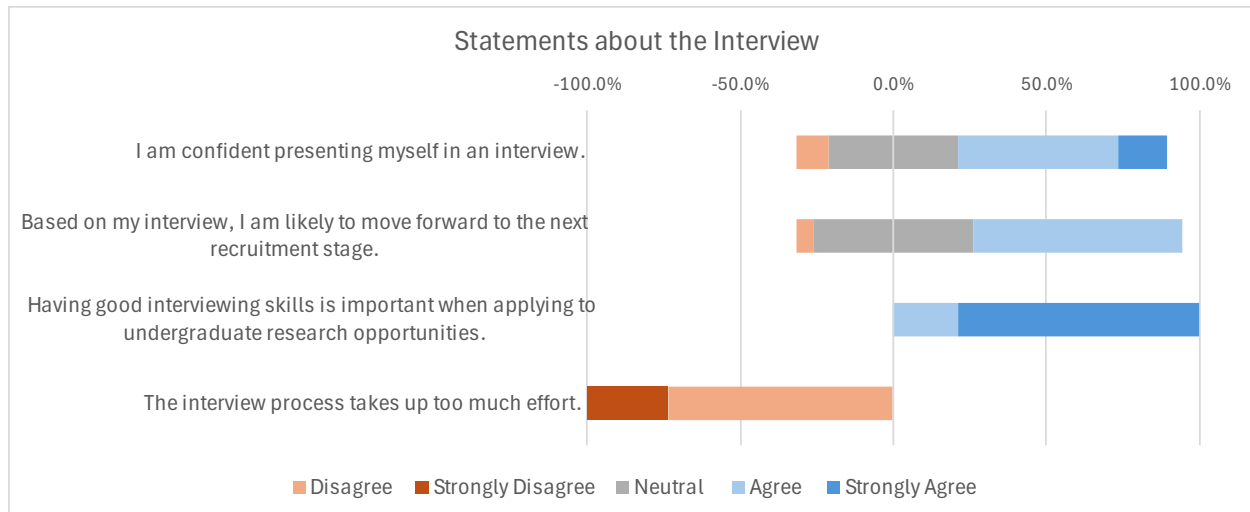
Figure 5: Applicants' perceptions of participating in an interview

4.2   Recruiter Results

Similar to the applicant surveys, the recruiter survey asked the participants to indicate their level of agreement with statements regarding the recruitment process. In this case, recruiter questions asked about their experience developing recruitment materials, organizing an information session, screening participants, and facilitating interviews. The first group of items, which referred to the development of recruitment materials, is shown in Figure 6. The results show that most of the participants feel confident that they can effectively develop recruitment materials. They also believe that this activity is important for undergraduate research with 89% of the participants agreeing or strongly agreeing with the statement. Unlike the applicant results, the recruiters do show higher perceptions of cost, with 22% of students considering that it takes too much time to develop these materials. This is further confirmed by the fact that no participant strongly disagreed with the statement that developing recruitment materials takes too much time.
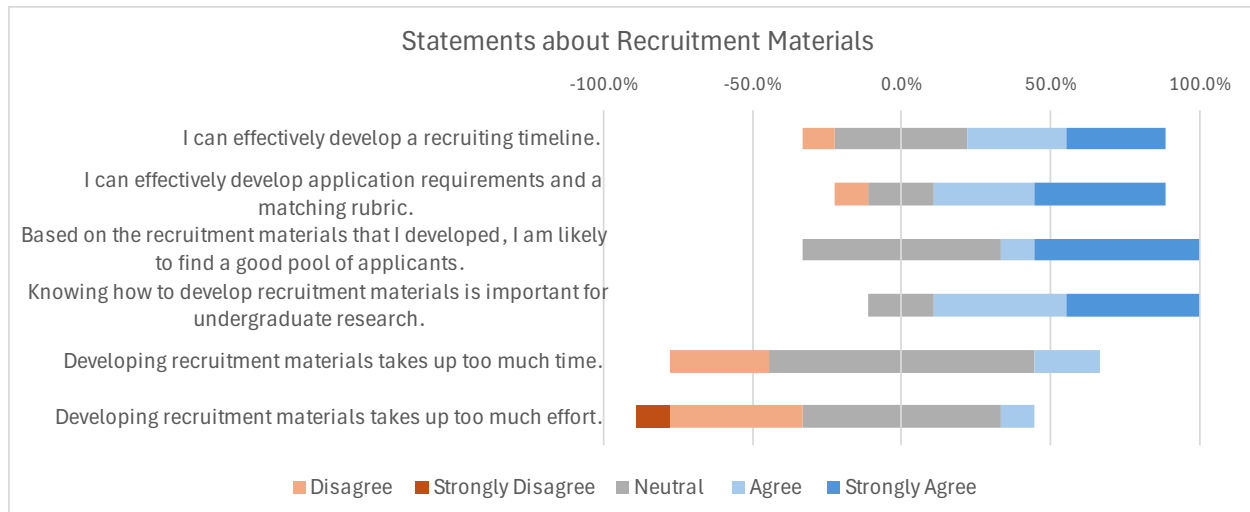
Figure 6: Recruiters' perceptions on preparing recruitment materials

In terms of organizing an information session, students showed higher levels of self-efficacy, expectations for success, and value than with the development of materials. As shown in Figure 7, 100% of the students agreed or strongly agreed that they were comfortable organizing information sessions, that they could answer questions effectively, and that this was an important task for the recruitment process. Most of the students also expressed that organizing an information session does not take up too much time, but none of them strongly disagreed with the statement. Overall, there is a higher perceived cost of recruiting to the program versus the cost perceived for applying.
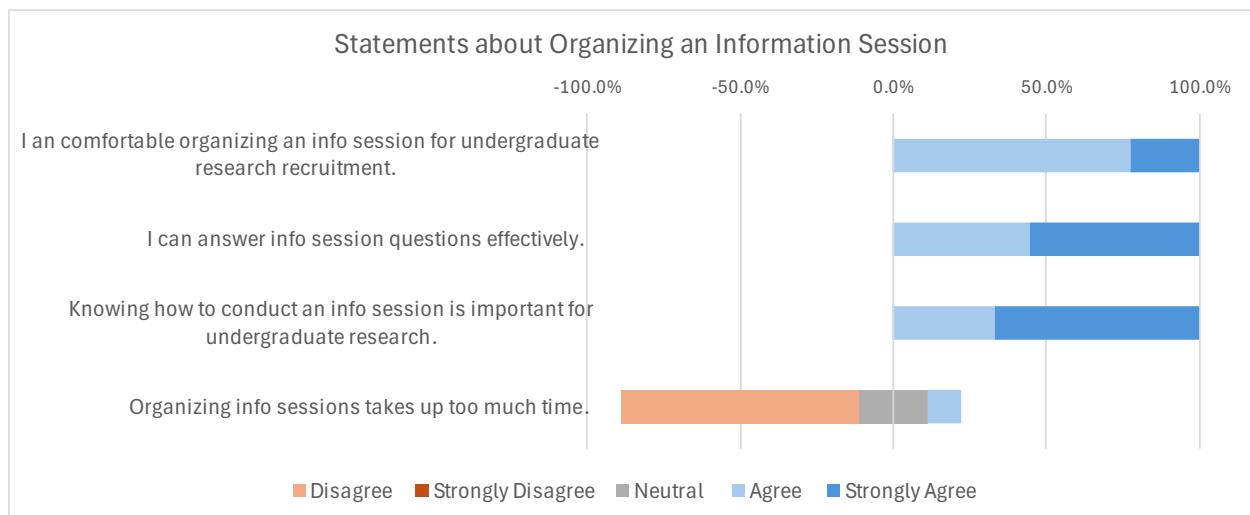

Figure 7: Recruiters' perceptions on organizing an information session

Figure 8 shows the items and results for the screening applicants' portion of the survey. These results are similar to the ones presented in the development of materials section with 89% of the participants agreeing or strongly agreeing with the self-efficacy, expectation for success, and

value items of the survey. Following the results from the last two sections, the recruiters disagree that screening applicants takes too much time and effort, but they do not strongly disagree with the statements. In fact, 44% of the applicants are either neutral or agree that screening applicants takes too much time.
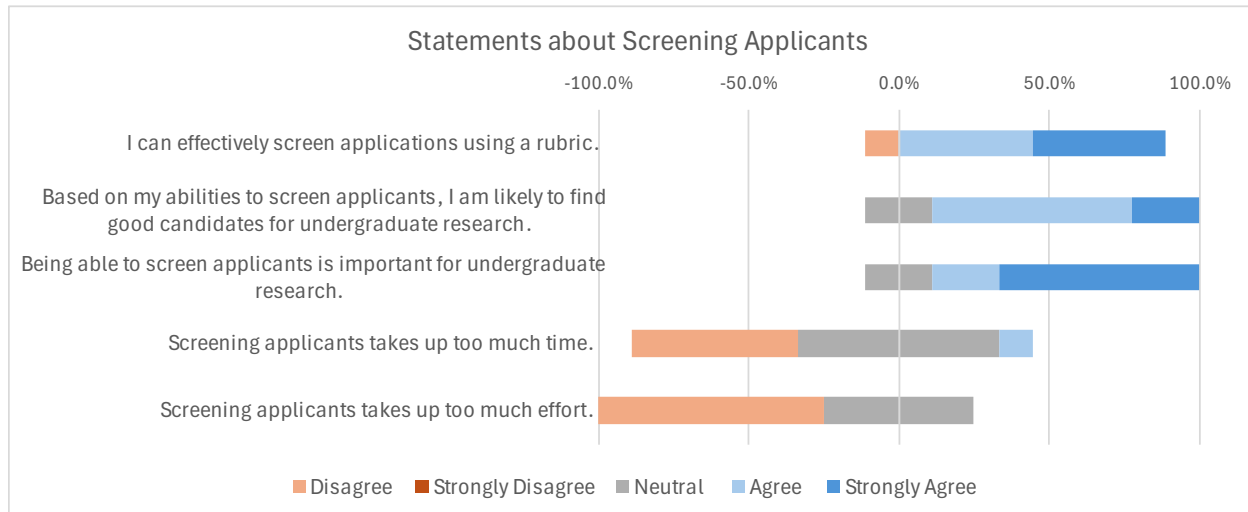

Figure 8: Recruiters' perceptions on screening applicants

Finally, Figure 9 shows the recruiters' perceptions on interviewing applicants. All recruiters considered interviewing applicants an important part of undergraduate research, which mirrors the opinion of the applicants. These results also show that all recruiters are comfortable asking interview questions, which is a higher level of self-efficacy compared to the applicants being interviewed. Recruiters also noted a similar cost for interviewing applicants as for the previous recruitment activities in terms of total disagree/strongly disagree scores, where most of them only disagreed that interviewing takes up too much time and effort.
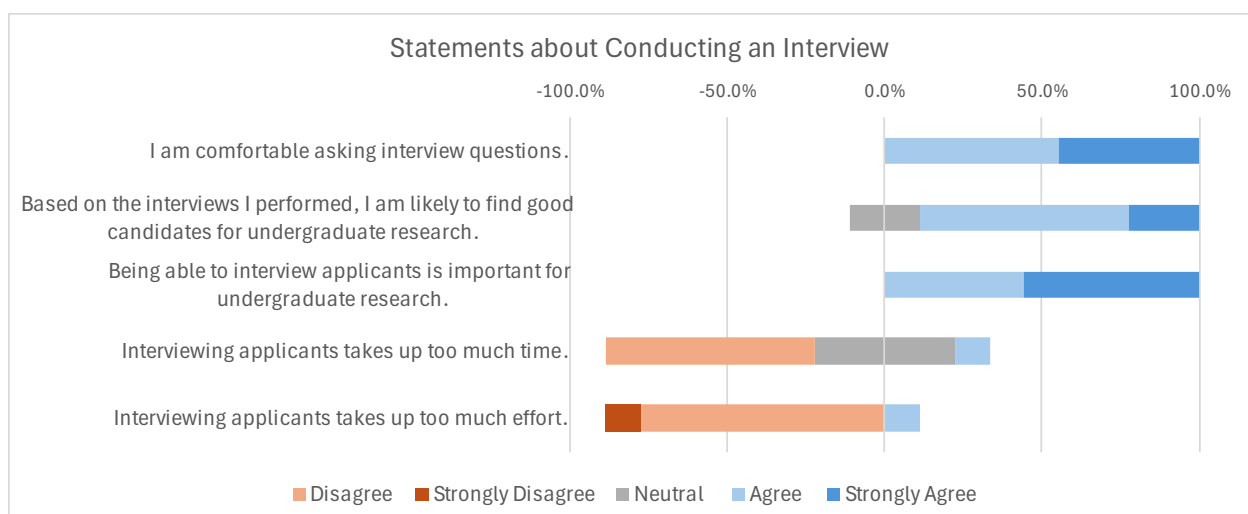

Figure 9: Recruiters' perceptions on interviewing applicants

5   Discussion

Overall, applicants understood the value of the different components of the recruitment process. Applicants largely indicated a low cost to complete the different stages of the process. What comes forward in the data is the relative expressions of efficacy with the different components of the process. Applicants who attended all felt that the information session was helpful in moving them forward, and indeed there was no tasking on the applicants' part other than attendance. Most of the applicants were comfortable with drafting resumes and interest letters. Both artifacts are likely quite familiar to students, as most universities require at least some form of a resume and an essay for application. The institute housing this program requires students to answer multiple essay-type questions in the application process. Students have likely had exposure to resumes in applying for work, scholarships or other opportunities. Many students are formally taught how to develop and prepare a resume in high school career development programs.

In those aspects of the program that students have had less scaffolding or exposure, namely the research proposal and interview components, students showed less confidence in their ability to perform. The implications for recruitment into an undergraduate program include accounting for students' lack familiarity with certain aspects of the recruitment process. For example, recruiting students and faculty placed significant value on the research proposal component of the application process. Applicants, however, placed a lower value on this activity and showed significantly reduced efficacy in development. This suggests that applicants may not devote as much resourcing to different aspects of the process, especially if relative weighting of the components (e.g. application rubric) are not provided. For those students who do perceive a high value in the activity, their lack of exposure to these sorts of application artifacts may be acting as a filter to the process – whether intended or not. If pre-existing knowledge or experience with proposal creation or interviewing processes is prerequisite for a program, this low self-efficacy is a valuable filter. For our program, where we intend to strengthen student skills, these disparate perceptions as compared to less important elements of the process (e.g. resume) suggests that moving forward it might be beneficial to direct students to supplemental resources to enable them to develop their skills in interviewing or drafting proposal so as not to inadvertently filter these students from the application pool.

The results from the recruiters' survey had similar implications. Most of the applicants were comfortable developing and facilitating recruitment activities. Since participant retention of the program is high, many of the students have participated in at least one recruitment cycle prior to this one. Even the students who are coming back for the first time have been part of the recruitment process as applicants before and therefore have some experience to draw from. By promoting a multi-year commitment to the program, students can build their recruitment skills either through personal experience or by learning from their student mentors. Since the teams are built around the idea of growth and mentorship, many of the recruitment materials are passed down from earlier years and improved on by the newer members.

When comparing the results from the applicants and the recruiters, there are two major themes. First, the recruiters' results showed higher levels of self-efficacy and expectations for success in the recruitment activities than those of the applicants. A possible explanation for this is the scaffolding, or lack thereof, mentioned previously. While the applicants might be developing their application materials for the first time, the recruiters have a support system that shares their expertise to facilitate the process. The second theme shows that the recruiters saw higher cost levels associated with the recruitment process than the applicants, especially in terms of time. While the cost in general was still offset by the value and expectancy for success, the recruiters felt a larger time burden throughout the process than the applicants. This trade-off between efficacy and cost comes from the fact that the recruiters must evaluate all the applications while applicants only have to devote time to their own materials. Moreover, the students already participating in the program tend to have a higher academic standing than those applying for the first time. Therefore, it is expected that their academic workload and other commitments might limit the time that they have to participate in the recruitment process. If the goal of the program is to grow year after year, there might come a time when the time commitment for the recruitment process might not offset its value to the returning students. Then, it will be important for the returning students to develop new recruitment strategies that redistribute the time load required for the process.

6   Conclusion

The main goal of this paper was to explore how students value the different aspects of recruitment via the lens of motivation theory. The results showed that both applicants and recruiters tended to agree that the various components of the recruitment process are quite valuable and relatively low cost to achieve. All students involved in the process indicated confidence with resume writing and interest statement generation, likely because of familiarity through prior exposure. For those aspects where students have less exposure, applicants noted significant less confidence in their ability to achieve, suggesting that scaffolding of the application materials could broaden the pool of applicants.

The findings of this study suggest that students value overseeing the recruitment process for UREs and the experiences that it offers. While participation in a research program is known to instill a culture of value in the ability to conduct research, this study shows that it can also deepen the students' appreciation for professional skills. While the current study focused on a particular URE program, these findings can serve as inspiration for other programs to shift towards a student-let recruitment process. By taking ownership of this process, students can acquire experience and skills that are often underdeveloped by the end of their college career. Finally, based on these findings, further research needs to be done to establish the scalability of student-let recruitment processes. As demonstrated by the results section, the time commitment needed from the recruiters is the biggest cost of participating in this activity. Therefore, new recruitment strategies must be developed to support the growth of the program in the long term.

References

[1] R. V. Shah, T. J. Albert, V. Bruegel-Sanchez, A. R. Vaccaro, A. S. Hilibrand, and J. N. Grauer, "Industry Support and Correlation to Study Outcome for Papers Published in Spine:," *Spine*, vol. 30, no. 9, pp. 1099–1104, May 2005, doi: 10.1097/01.brs.0000161004.15308.b4.

[2] O. Meade, M. Millar, T. Hall, C. O'Regan, and D. O'Hora, "Problem-based, research-led learning for our times: The case of Vertically Integrated Projects in higher education," in *10th International Conference on Higher Education Advances (HEAd'24)*, Universitat Politècnica de València, Jun. 2024. doi: 10.4995/HEAd24.2024.17138.

[3] S. E. Rodenbusch, P. R. Hernandez, S. L. Simmons, and E. L. Dolan, "Early Engagement in Course-Based Research Increases Graduation Rates and Completion of Science, Engineering, and Mathematics Degrees," *CBE Life Sci. Educ.*, vol. 15, no. 2, p. ar20, 2016, doi: 10.1187/cbe.16-03-0117.

[4] A. Barry, G. Born, and G. Weszkalnys, "Logics of interdisciplinarity," *Econ. Soc.*, vol. 37, no. 1, pp. 20–49, Feb. 2008, doi: 10.1080/03085140701760841.

[5] D. A. Cook and A. R. Artino, "Motivation to learn: an overview of contemporary theories," *Med. Educ.*, vol. 50, no. 10, pp. 997–1014, 2016, doi: https://doi.org/10.1111/medu.13074.

[6] H. M. Matusovich, R. A. Streveler, and R. L. Miller, "Why Do Students Choose Engineering? A Qualitative, Longitudinal Investigation of Students' Motivational Values," *J. Eng. Educ.*, vol. 99, no. 4, pp. 289–303, 2010, doi: https://doi.org/10.1002/j.2168-9830.2010.tb01064.x.

[7] Q. Li, D. B. McCoach, H. Swaminathan, and J. Tang, "Development of an Instrument to Measure Perspectives of Engineering Education Among College Students," *J. Eng. Educ.*, vol. 97, no. 1, pp. 47–56, 2008, doi: https://doi.org/10.1002/j.2168-9830.2008.tb00953.x.

[8] B. D. Jones, M. C. Paretti, S. F. Hein, and T. W. Knott, "An Analysis of Motivation Constructs with First-Year Engineering Students: Relationships Among Expectancies, Values, Achievement, and Career Plans," *J. Eng. Educ.*, vol. 99, no. 4, pp. 319–336, 2010, doi: https://doi.org/10.1002/j.2168-9830.2010.tb01066.x.

[9] J. A. Maxwell, "Designing a qualitative study," *SAGE Handb. Appl. Soc. Res. Methods*, vol. 2, pp. 214–253, 2008.

[10] I. Etikan, "Comparison of Convenience Sampling and Purposive Sampling," *Am. J. Theor. Appl. Stat.*, vol. 5, no. 1, p. 1, 2016, doi: 10.11648/j.ajtas.20160501.11.

[11] J. K. Flake, K. E. Barron, C. Hulleman, B. D. McCoach, and M. E. Welsh, "Measuring cost: The forgotten component of expectancy-value theory," *Contemp. Educ. Psychol.*, vol. 41, pp. 232–244, Apr. 2015, doi: 10.1016/j.cedpsych.2015.03.002.

[12] S. A. Williams, B. Lutz, C. Hampton, H. M. Matusovich, and W. C. Lee, "Exploring student motivation towards diversity education in engineering," in *2016 IEEE Frontiers in Education Conference (FIE)*, Erie, PA, USA: IEEE, Oct. 2016, pp. 1–5. doi: 10.1109/FIE.2016.7757565.

[13] D. M. Elston, "Participation bias, self-selection bias, and response bias," *J. Am. Acad. Dermatol.*, vol. 0, no. 0, Jun. 2021, doi: 10.1016/j.jaad.2021.06.025.