Board 287: Fostering Leaders in Technology Entrepreneurship (FLiTE): Second Year Progress

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Fostering Leaders in Technology Entrepreneurship (FLiTE): Second Year Progress

The NSF S-STEM-funded program titled Fostering Leaders in Technology Entrepreneurship (FLiTE) hosted by the School of Engineering+Technology at Western Carolina University has now completed its second year of operation. The program aims to create graduates who bring impactful contributions to industry employers or create new businesses with their own original technology innovations. FLiTE has continued its mission to cultivate entrepreneurial and growth-oriented thinking among financially needy engineering and technology students. With the first- and second-year classes aboard, the program currently serves eighteen students. Program activities for the 2023 calendar year included the induction of a newly recruited class, connection with campus resources and veteran entrepreneurs, and scholar participation in a formal pitch development course. Pre- and post-year surveys were completed by the scholars to characterize personal perceptions of their initial and developing aptitudes toward the entrepreneurial mindset. This paper describes the cohort teaming sessions, invited speakers, informal and formal pitch presentations, and survey results from the fall 2022 and spring 2023 semesters. Summary results show improvement in scholar perceptions of entrepreneurial dimensions entrepreneurial targeted by program interventions. Findings from these activities may inform the curriculum at Western Carolina University and the content of similar entrepreneurship programs.

Keywords: NSF, Scholarship Program, Entrepreneurship, Project Based Learning (PBL), Learning Community, Entrepreneurial Mindset, Engineering, Engineering Technology

1. Introduction

The National Science Foundation (NSF) funded FLiTE scholarship program [1] at Western Carolina University (WCU) aims to provide opportunity for engineering and engineering technology students with financial need to build qualities of the entrepreneurial mindset that may contribute to their value as future professionals or to their launch of technology startup businesses. The program brings together student scholars from across disciplines in a vertically- and horizontally-integrated learning community to engage in technology invention ideation supported by and mentored through interactions with business leaders, subject matter experts, and campus resources.

The NSF grant which supports the FLiTE program was awarded to WCU in January 2022. It is valued at $1,495,416. The program is expected to provide scholarships and project funding to thirty-six students over its planned six-year duration. This paper outlines the program plan and details of activities and success metrics for the applied interventions in spring and fall 2023.

2. Program Objectives

Motivated by the financial needs of WCU's student population along with the commercial climate and employment needs of the surrounding region, the program takes advantage of the host department's strengths in project-based learning (PBL) and engagement with local industry to help foster those dimensions of the entrepreneurial mindset which are skills-based, and thus more malleable than qualities that may be rooted in an individual's personality. These include

having a future-focus, a tendency to generate multiple problem solutions, a tendency to generate action plans, self-confidence, optimism, persistence, and team-orientedness [2], [3]. Through regular group interactions, ideation sessions, and active product development interlaced with the PBL courses of the available degree programs, the FLiTE program aims to inculcate a regular practice of creativity, professional self-efficacy, and teaming skills among the students [1].

In a practical sense, the FLiTE program seeks to give students the financial means to persist toward their degrees while also developing the innovation and business acumen to launch their own technology startup. Through progressive mentoring by the program directors and School faculty, the FLiTE students will take their ideation experiences back into the classroom (see the PBL course sequence of Table 1) to implement their ideas supported by grant financial resources and their classmates.

Table 1 – PBL course sequence [1].

Year	Course
Freshman	ENGR 199 – Introduction to Engineering Principles and Practices I
Sophomore	ENGR 200 – Engineering Principles and Practices II
Junior	ENGR 350 – Engineering Principles and Practices III
Senior (fall semester)	ENGR 400 – Engineering Capstone I
Senior (spring semester)	ENGR 450 – Engineering Capstone II

If successful, the program will use lessons learned from this transition to formally integrate entrepreneurism into the curricula of the School of Engineering+Technology. Dissemination of this work may prove beneficial to similar programs outside of WCU.

3. Program Description

The FLiTE program is planned to last six years. In each of the first three years, the program has capacity to bring in twelve new scholars, for a total of thirty-six participants. All scholars are eligible for renewal of their scholarship each year for the four years of their degree. This progression is shown in Table 2.

Table 2 – Proposed number of scholars by program year [1].

Program Year	Freshmen	Sophomores	Juniors	Seniors	Graduating	Continuing
2022-23	12				0	12
2023-24	12	12			0	24
2024-25	12	12	12		0	36
2025-26		12	12	12	12	24
2026-27			12	12	12	12
2027-28				12	12	0

The scholar cohort meets weekly. During meetings, the scholars hear presentations by program directors, business leaders, and representatives from campus resources. Between meetings, scholars meet in teams of two to three people to discuss product ideas. These are presented and discussed in subsequent meetings as 1-minute pitches. After a series of these short pitch sessions, the ideas are reconsidered by the larger group to select concepts suitable for pursuit in ENGR350

and/or ENGR400/450 capstone projects. Ideas deemed worthy of future consideration in these courses receive financial support from the FLiTE program.

Research goals of the program include characterization of FLiTE program interventions on (1) development of the malleable dimensions of the entrepreneurial mindset; (2) originality and quality of invention ideas as reflected in ENGR350 projects; and (3) promotion of diversity in the regional technology workforce.

4. Second Year Results

Recruitment, Retention, and Demographics

The program began the [inaugural] 2022-23 academic year with ten scholars enrolled. One scholar left the program after the fall 2022 semester due to academic difficulties. Two scholars left the program after the spring 2023 semester to attend other institutions. The program retained seven students to begin the 2023-24 academic year. As shown in Table *2*, the program has a capacity of twenty-four participants in the second year. Thus, recruiting for fall 2023 aimed to fill seventeen available seats.

The recruiting campaign began with an email solicitation to students who had been accepted to WCU and who had declared interest in a degree program in the School of Engineering + Technology. The email included a link to the scholarship application on WCU's Scholarship Manager website. The application consisted of essay responses to the following questions. These questions were altered from the previous year [1] with the goal of eliciting more creative and detailed responses.

1. Describe your activities/hobbies outside of school. (500 words max)

2. Describe a situation in which you have demonstrated an innovative approach to some aspect of your life. (500 words max)

3. Describe a situation when you had to persist to overcome a challenge and achieve a long-term goal. (500 words max)

4. Describe a new product or business idea that you might like to pursue or that you have worked on previously. Describe the motivation behind your product or business and how you would execute the concept. You may optionally upload a video or other media file to accompany your written response. (500 words max; 25 MB max upload file size)

The solicitation was sent to 406 students. Thirty-one applications were received. Some applicants were removed from consideration for failing to meet financial need requirements defined as Federal Pell Grant eligibility. Based on the quality of essay responses, reflected commitment to the goals of FLiTE, and high school GPA, twelve applicants were selected for participation. This brought the total number of students participating to nineteen, leaving five seats unfilled. Upon completion of the fall 2023 semester, one first-year student left the program due to academic difficulty, leaving the cohort with eighteen students to begin the spring 2024 semester. The net

retention of students who began the program since inception is 81.2%, which exceeds that of WCU for first-time, full-time freshmen.

The maximum budgeted scholarship award for an individual participant is $3,150 per semester ($6,300 per academic year). The average award across the cohort based on unmet financial need (after other scholarships, loans, or grants) for spring 2023 was $3,085, with two students receiving slightly less than the maximum amount. For fall 2023, the average unmet need was $3,133 with two students receiving less than the maximum amount.

Scholars select one of the available degree programs in the School of Engineering + Technology including BS-Engineering, Mechanical Concentration (BSE-ME), BS-Electrical Engineering (BSEE), BS-Electrical and Computer Engineering Technology (BS-ECET), and BS-Engineering Technology (BSET). Figure 1 shows the distribution of scholars by major and gender as of the conclusion of the fall 2023 semester. Demographic data related to ethnicity are no longer collected by NSF.

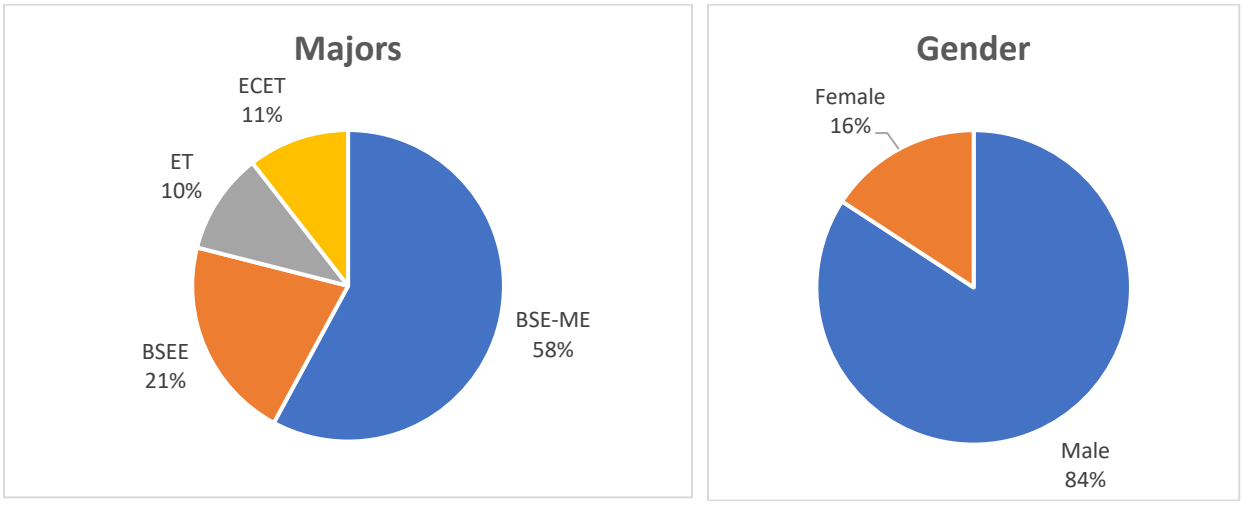

Figure 1 – Scholar demographics by major and gender.

Cohort Activities

Spring 2023. During the spring 2023 semester, scholars participated in a business pitch development course offered by First Flight Venture Center, a technology startup incubator in Research Triangle Park, North Carolina. The course, titled *Propeller* [4] is based on the curriculum developed by the Wendy Kennedy Institute [5]. The course was held by telepresence over eight weeks between January and April 2023. During the course, the scholars were guided through a process of building a formal business pitch suitable for presentation to potential investors. The course culminated in a *Demo Day* event in which each scholar presented their pitch to selected WCU faculty and professional startup *Navigators* who advise prospective entrepreneurs through First Flight Venture Center. Outcomes of the pitch development course were positive, with scholars appearing to grow in self-efficacy through the process.

In March 2023, a group of four selected scholars, along with the program directors, were invited to present their personal stories of participation in the FLiTE program at a meeting of WCU's Chancellor, Provost, and Board of Trustees. The scholar presenters were well-received, with feedback from the event being uniformly positive.

Fall 2023. During the fall 2023 semester, scholars attended weekly cohort meetings. Meetings included a tour of WCU's prototyping facilities and machining labs (freshmen only), a collection of invited business leaders from the area, ideation sessions, and speakers from campus resource units. Speakers/subject areas are listed below. Scholars typically showed great interest in the topic at hand, with questions from scholars being posed at length.

- WCU Center for Career and Professional Development
- Review of past senior capstone projects
- Former industrial designer and bookstore entrepreneur
- WCU Corporation for Entrepreneurship and Innovation (CEI)
- WCU Library – market analysis tools
- CEO of a local soap company
- CEO of a local robotics company
- Founder of a local military textiles manufacturer
- CEO of a commercial tent manufacturer

Ideation sessions occurred on three occasions with scholars divided into *vertically-integrated* teams of 3-4 members wherein new freshmen scholars were led by FLiTE sophomore students. Teams were required to meet outside of the weekly timeslot to discuss and propose a product idea. These ideas were presented as 1-minute pitches during the cohort meeting of the following week. Product concepts were limited to those that could be developed and prototyped at WCU, which precluded any which might be unrealistic. Over the course of the semester, the teams collectively pitch a total of 32 product ideas. An end-of-semester session was held in which teams were tasked with ranking the viability of the ideas generated by a different team. After this ranking, all teams were gathered to choose the top ideas from those ideas which had been highly ranked by each team. As in the previous year, discussion included speculation about implementation, marketing, and business aspects of bringing each respective idea to market.

Evaluation of Scholars

Participation in the FLiTE program includes a commitment to maintain a 3.25 grade point average and to participate fully in cohort activities. Attendance at meetings is monitored. Scholars are expected to provide advance notice of planned absences from cohort meetings. Scholars' grades are monitored periodically throughout the semester. Scholars who struggle academically are invited to meet with a program director for one-on-one mentoring. Average GPA by program year, and cumulatively is given by Table 3. All scholars who completed year 1 of the program with less than a 3.25 GPA showed improvements in academic achievement sufficient to allow them to remain in the program on *at-risk* status. Four scholars entering year 2 of the program encountered significant academic difficulty. One of these left the university. Individualized mentoring plans will be constructed to assist those who may wish to remain in the

program. Scholars who complete the 2023-24 academic year without achieving a 3.25 GPA will be placed on *at risk* status.

Table 3 – Cohort GPA by year of program entry and cumulative.

Cohort Class	Spring 2023	Fall 2023	Cumulative
Year 1	3.36	3.38	3.41
Year 2	N/A	2.28	2.28
Average	3.36	2.83	2.84

In general, the arrival of new first-year students to the cohort appeared to enrich group interactions and discussion during weekly meetings. Participation was typically lively, with most scholars contributing to group discussions and asking substantive questions during speaker presentations.

Perceptions

Scholars from Year 1 were asked to take a survey upon entering the program. They were then asked to retake the same survey on completing the academic year. The survey was composed of eighty-nine statements/dimensions of entrepreneurial aptitude for which scholars were asked to rate their agreement with, or identification with each on a 4-point Likert scale. Aggregate scholar ratings on the malleable dimensions of entrepreneurship are given by Table 4.

Table 4 – Student perception changes of malleable qualities of entrepreneurship. Percentages computed as coupled responses (Strongly agree + Somewhat agree) or (A lot + A moderate amount).

Quality	Fall 2022 (Pre) (N = 8)	Spring 2023 (Post) (N = 5)	Change
Future focus (vision, goal-oriented, innovation)[1]	87.50%	77.78	-9.72%
Tendency to generate multiple problem solutions[1]	87.50%	100.00%	12.50%
Tendency to generate action plans[1]	62.50%	83.33%	20.83%
Self-confidence[1]	62.50%	66.67%	4.17%
Optimism[2]	87.50%	100.00%	12.50%
Persistence[1]	100.00%	100.00%	0.00%
Team-oriented[2]	100.00%	100.00%	0.00%

1. A lot, A moderate amount, A little, Not at all.
2. Strongly agree, Somewhat agree, Somewhat disagree, Strongly disagree.

In general, the data show most scholars reporting an increase in several of the malleable dimensions of entrepreneurship. Of note is the perceived decrease in qualities related to future focus, assessed here as a combination of vision, goal-oriented behavior, and innovation. This decrease may be attributable to program novelty for Year 1 scholars whose long-term goals and familiarity with entrepreneurialism are coalescing. It is envisioned that, having been through a year's exposure, these scholars will act as leaders for Year 2 students, enhancing the future focus of the cohort as a whole.

In addition to the scholars' self-perceptions of their entrepreneurial development, the survey also included four open-ended questions on general qualities of the program and how it may have affected the scholars individually. These and selected responses are shown inTable 1 below.

Table 5 – Open-ended survey questions and responses.

Question	Responses
What was the most positive aspect of participation in the FLiTE program for you over the past year?	The best part of this program for me was being connected with peers and professors, but the opportunities presented also held lots of benefits.
	Having a group to support each other and help each other learn and gain experience in our field.
	Learning new ways to improve myself and others.
	For me, I believe that the most positive aspect was the short but consistent practice at public speaking through the elevator pitches, etc. I think that being able to speak publicly is just really important, and as such, I am glad that I've been able to develop it over this past year.
	I liked being able to go to other professors' office hours for help on stuff. I really liked the speeches, from both the guest speakers and the directors. I liked being able to take myself out of my comfort zone when I went to the meeting with the Board of Trustees.
	I was given a lot of knowledge and tools for creating and promoting new ideas/products.
What would you change about the FLiTE program for the future?	The only thing I would change is the time commitment. I enjoyed the program; however, in some cases it felt like the time could be used in much better ways.
	I would change the meetings to be something different each time, maybe have a study meeting where we get help with homework or a advice meeting where we can talk through our career goals and figure out our future plans.
	More hands and group projects.
	Based on this year, I would say that we should put more time into the ideation phase for our products and services. This is because I think having an idea that one can be passionate about is incredibly important, and I think only a few of us were able to home in on something like that.
	I would not continue with the Propeller program. I would like to do more exercises where we get comfortable talking in front of the whole room before presentations, like a low-stakes introduction.
	More hands-on experiences (guest speakers, presentations from teachers/speakers, skill building exercises).
Discuss whether and how your participation in the FLiTE program has changed the way you approach your education.	I feel that it did. I have become more confident in talking to professors and being more creative overall.
	I definitely think it has helped me see that it isn't as intimidating as I thought and that the [director's are] there to help you learn and grow
	The FLiTE program has helped my problem-based approach to learning, and practices towards engineering.
	I think that my participation in FLiTE has allowed me to look deeper into my education, and the different ways that it has allowed me to grow. For instance, whenever I had a presentation for a class in this last year, I feel that FLiTE prepared me, perhaps not for the topic, but for the actual giving of that presentation. FLiTE has kind of helped me develop this mindset that "this is my idea (or topic), and I know my product best, so show them (the audience) what makes it important."
	It has become much easier to talk to professors for me. At first, I was terrified to do so, but I found out that the professors are pretty cool people.

	FLiTE has given me a motivation to pass and excel in my education and encouraged me to try new challenges throughout it.
Discuss whether and how your participation in the FLiTE program has changed the way you think about your future career path.	It has changed the way I think about my future career. I feel that it has given me the confidence to explore different paths and be more particular about the role I will hold one day.
	I definitely think it has made me think more about the details of my future career path, and it has got me interested in actually finding companies and specific work that I find interesting
	The FLiTE program played a role towards my future career path since it gave me a better understanding towards engineering.
	Before I became involved with the FLiTE program, I had assumed that I would come to college, get my degree, pursue a Master's, and go into the aviation electronics field. However, after participating as I have in the past year, I have realized that there are some many more options available to me, and that the limit to those options is how much effort I am willing to make my vision come true.
	I had never really considered being an entrepreneur before the FLiTE program, and while I am still not sure that it's my career path, I am considering it.
	I see a better chance for success in my future thanks to the entrepreneurial and financial tools provided to me.

These open-ended responses reflect positive outcomes of the interventions applied within the program thus far. Some comments suggesting programmatic changes have motivated operational modifications during the most recent semester, such as the inclusion of skill building activities, and exposure to campus resources.

It is noted that the number of scholars surveyed is small. Scholars were not required to complete the survey, and as previously noted, some scholars left the program. Thus, the data represent a subset of the cohort for both pre- and post- assessments. It is acknowledged that further data will be needed to conclude that the observed trends are sustainable and replicable.

External Evaluation

The program uses external evaluation services provided by NC State University Industry Expansion Solutions [6]. The program underwent its periodic external review at the end of the fall semester in December 2023. The reviewer was provided with information on all program activities for the year. The reviewer interviewed program personnel and conducted a focus group with the scholar cohort. The reviewer generated a formative evaluation of the program [7]. In general, feedback from the evaluation was positive. Items of interest include the following.

- An increased level of comfort among the scholars and a perception of increased community cohesion among the cohort was apparent.
- The Propeller program was not unanimously enjoyed due to the timeslot in which it was offered being particularly inconvenient. The scholars did find the exercises involved in the program to be of value and the ideation process enjoyable.
- Switching the recruitment process to make use of the university's scholarship portal gave the scholarship solicitation an air of legitimacy that was not previously attained.
- Difficulties in attracting high-quality applicants may be alleviated by getting the word out to regional high school guidance counselors who may be able to recommend the program to their students.

5. Conclusions and Future Work

Participation in the FLiTE grant has generally been energetic, with most scholars contributing substantively to discussions and group activities. The directors have attempted to cultivate a conversational environment at weekly meetings and to encourage those present to take advantage of the wisdom and expertise of invited speakers. More reticent scholars have received individual mentoring to encourage their active involvement.

Speakers at weekly cohort meetings have continued to be of high quality. Question-and-answer sessions following speaker presentations have reflected scholars' thoughtful consideration of the needs and concerns of founding and operating a business. It has been observed that the range and quality of these discussions represent an upward trend in the level of insight shared by members of the cohort and their vision of themselves as future entrepreneurs.

Recruitment continues to be a challenge to the program. The program is currently under-enrolled compared to the proposed headcount. The number and quality of applications are not sufficient to allow awarding of all available scholarship funds. Measures to generate greater exposure for the scholarship opportunity are being considered. Projecting a continuation of the current response rate to program solicitation into the third and final recruiting year, the program directors may seek to increase the level of the default award.

As ideation sessions have progressed, the quality of student proposals has appeared to level off, giving the perception that the present maturity of students may be a limiting factor in the scope of their innovative vision. In the spring 2024 semester, scholars will participate in a public pitch competition sponsored by WCU's College of Business. With the goal of broadening the pool of ideas generated by the scholars, the program will attempt to seed pitch teams with candidate technology areas intended to inspire creativity.

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References

[1] P.M. Yanik, C.W. Ferguson, A. Ritenour, W. Cagle, and S. Rowe. "Fostering Leaders in Technology Entrepreneurship (FLiTE): Program Goals and First-Year Activities." *Proceedings of the American Society for Engineering Education Annual Conference and Exposition*, 2013.

[2] M.H. Davis, J.A. Hall, and P.S. Mayer, P.S. "Developing a New Measure of Entrepreneurial Mindset: Reliability, Validity, and Implications for Practitioners." *Consulting Psychology Journal: Practice and Research*, 2015.

[3] D. Hayes, and W. Richmond. “Using an online assessment to examine entrepreneurship student traits and to measure and improve the impact of entrepreneurship education.” *Journal of Entrepreneurship Education*, 2017
[4] *Propeller Pre-accelerator: Finding the Business Value in New Ideas*. Available at https://www.ffvcnc.org/propeller (Accessed: January 9, 2024).
[5] *WKI Wendy Kennedy – Innovation and Design Thinking Tools*. Available at: https://wendykennedy.com/ (Accessed: January 9, 2024).
[6] *NC State University Industry Expansion Solutions*. Available at: https://www.ies.ncsu.edu/ (Accessed: January 28, 2024.
[7] NC State University Industry Expansion Solutions. *Fostering Technology Entrepreneurship through a Project-Based Learning Community – Annual Evaluation Report Year 2*. WCU Internal Document, 2024.