Project Based Learning Program for Nuclear Workforce Development Phase I: Outreach, Recruiting, and Selection

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I. Abstract

Funded by U.S. Nuclear Regulatory Commission, Project Based Learning Program for Nuclear Workforce Development at Western Carolina University (WCU) has been designed to provide scholarships for $5000 per semester for engineering (electric power and mechanical concentration) students who are pursuing an educational emphasis in nuclear power and who desire to contribute to the nuclear-related national workforce. The main objective is to use these scholarships to attract an inaugural class of students who will initiate our program for serving nuclear-related industry and academia leveraging WCU's engineering project based learning sequence. Our objective is also to increase the quantity and diversity of students majoring in these engineering programs. This paper presents Phase I efforts and the results in terms of outreach, recruiting and selection at WCU.

Selected students are expected to be sophomore through seniors who would be pursuing an educational emphasis in nuclear power, engaging in nuclear-related projects through WCU's engineering project-based learning sequence and who have agreed to the terms of the scholarship program which will include an agreement to work in nuclear-related employment for 6 months for every complete or partial year of support awarded. The freshmen students were not included in the selection pool to address short term workforce needs of nuclear industry and because of the lower freshmen retention rate in comparison to higher academic levels.

To that end, an outreach and recruiting effort was carefully administered to target and attract students interested to be part of the nuclear related workforce in the U.S. First, an outreach effort targeting regional area community college transfer students and existing students in the university was organized to advertise and promote the scholarship program. This effort included community college visits, participation in college day fairs, classroom visits and internet posting through a website.

Secondly, a scholarship selection committee was formed by the university faculty, staff, and two industry advisory board members to provide a fair selection process. The selection criteria included grade point average, SAT/ACT scores, financial need status, involvement in extracurricular activities, recommendation letters, essay writing skills and whether the candidate was from an underrepresented group in engineering. Each committee members' rankings were aggregated equally to figure out the overall student eligibility ranking.

Finally, the candidates were contacted with official scholarship offer letters. The selection of seven candidates whom all accepted the offers were realized in two rounds of selection cycle. In order to implement an evaluation plan with the purpose of measuring this project's early impact in attracting and recruiting students for careers in nuclear related fields, a first semester intake survey of not only award candidates but their peers in the Engineering program was conducted.

II. Introduction

In the early 2000's, forecasters believed the United States was on the verge of a nuclear renaissance. Tremendous growth in the energy industry was expected at that time since the average age of the nuclear power sector was 48 years of age which ranked among the oldest in any US industry [1]. Many colleges and universities geared up new programs with help from federal agencies such as the Nuclear Regulatory Commission (NRC) and the Department of Energy (DOE). Over 40 college programs across the country were developed to create a pipeline to help fill the shortage of workers [2]. The majority of the programs were two-year Associate degree programs designed for entry level positions in nuclear fields. At that time, the NRC was processing applications for 22 new reactors for the nuclear power industry. Community College Week conveyed that "companies generally need up to 1,800 engineers and other workers during construction of a new reactor, which typically then requires between 400 and 700 high-skill workers when it becomes operational" [3]. In 2011, there were 104 operating reactors in the US, and the Nuclear Energy Institute (NEI) expected the need to replace 25,000 of those workers by the year 2016 [2].

Nuclear was not the only energy sector aching for workforce development. "In 2014, recruitment and employment agency Manpower Inc. issued a report stating that while jobs in the U.S. energy sector are expected to nearly double to 3 million by 2020, 72 percent of energy employers surveyed are worried their inability to find quality candidates would hamper North American competitiveness." [4]. While the renaissance of nuclear has been slow to erupt, much of the government focus on energy in more recent years has been through renewable sources in efforts to reduce emissions and become more environmentally friendly. In a current Columbia Energy Exchange podcast, Maria Korsnick, president of NEI, explains that nuclear energy is gaining favor with environmentalists. Despite the wave of reactor shutdowns countering the renaissance, Korsnick believes research developments in nuclear reactors will make the industry more compatible to green energy, but she warns that once the decision is made to close a reactor, it cannot be re-opened [5].

The reliability of the US energy supply suffers without the aid of nuclear energy. Under close scrutiny, the 2018 PJM report shows scenarios where power generation would not be enough to meet demand, such as in times of cold winters [6]. With this in mind, individual states are coming forward with policies that support the nuclear industry. Korsnick shows the relativity of energy generation between nuclear and renewable sources by suggesting that the "90 million megawatt hours being shut down in nuclear are equivalent to the range of all the wind power collected west of the Mississippi" [7]. Nuclear energy is of the top most in reliability having a capacity greater than 90% at a longevity of more than 15 years.

Nuclear energy has a high-volume output and carbon free emissions. By sustaining nuclear in the US, policy makers can balance out the price and availability of energy. Moreover, the nuclear industry employs thousands of workers. Current outlooks indicate that next generation will be more interested in taking care of our resources which will make for a better relationship between renewable energy and nuclear energy. "Based on current figures and actual hiring over the past several years, the nuclear industry expects to hire about 4,000 workers a year for the next five years, for a total of 23,000 workers" [5]. This figure holds steady from the previous forecast that

come to fruition in the early 2000's. Furthermore, "for every 100 nuclear power plant jobs, 66 more jobs are created in the local community" which can account for economic growth in regions where slow or no growth have occurred [5].

Nuclear energy is gaining momentum in the political arena. "On September 6, 2018 Sens. Lisa Murkowski (R., Alaska) and Cory Booker (D., N.J.) introduced S. 3422, the Nuclear Energy Leadership Act (NELA), bipartisan legislation intended to reestablish U.S. leadership in nuclear energy by launching public-private partnerships between the federal government, research institutions, and industry innovators" [7]. This bill will promote educational opportunities and initiatives in the nuclear workforce development sectors. In addition, on January 14, 2019, President Donald Trump signed the Nuclear Energy Innovation and Modernization Act (NEIMA) (S. 512), whose purpose is to modernize the U.S. Nuclear Regulatory Commission's functions by establishing a new budget and fee structure and developing a revised licensing framework for advanced nuclear reactors" [8]. With the new policy changes and more federal presence, there is good news for the energy sector as a whole. National defense, climate change, and global competitiveness are factors that may help spur on new developments in nuclear as well.

Nuclear power is approximately 8% of global generation. Collectively, there is a global movement in the recognition of nuclear as a viable energy source, especially since global emissions reached an all-time high in 2018 [5]. Other countries are finding ways to use nuclear as a primary source of energy. Korsnick points to France, Finland, and Canada as examples of strong viable nuclear programs. She also points out that in the US, every state that has closed nuclear plants have increased carbon emissions [5]. Nuclear facilities are aging. When the facilities came on board, their initial appreciation was 40 years, but over time, they have been recertified to 60 or an upcoming 80 years in some cases.

What is the next step for nuclear energy? There are varying ideas. "The pace of technological development within the generation industry continues to increase, and so do applications for digitization" [9]. Small modular plants are being researched for future widespread capacity. With more agile nuclear facilities, it would be easier to use this option as a backup for renewable energy supplies instead of being linked to coal as is the state of most current systems. With the aging of nuclear facilities, more focus has been put on the supply chain base as well. Industry partners who have been lost in the past must be brought back on line to support the newer technologies and research projects. "Building these relationships requires a commitment from both sides. Industry partners must have enough work volume to warrant investing in training to meet the nuclear generation industry's specific needs" [9].

The American Nuclear Society (ANS) and NEI are in agreement that the place to start partnerships is within education. STEM education programs in K-12 are being launched across the US to help overcome such shortages. "In October 2018, ANS past president and subject matter expert team leader Dr. Eric Loewen and ANS's Janice Lindegard introduced Navigating Nuclear: Energizing Our World™, the Society's new K-12 STEM education program" [10]. Other broader attempts at recruitment from K-12 come in the shape of career fairs, open houses, engineering camps, and outreach events. Students who have a first-hand experience with exposure to engineering are more likely to enter an engineering program of study. "Active

engagement with faculty in recruiting events attracts more students, and hands-on activities are the preferred method of outreach" [11]. Educational outreach events sponsored by industry or industrial represented agencies bring together all three pieces (industry, students, and educators) to make a collective success for recruiting. In multiple studies on recruitment in engineering fields, there are several best practices that surfaced [11,12,13]. Class visitations, distribution of flyers, cooperation with faculty and advisors from pipeline programs, local promotional news feeds, websites, hands-on workshops, and email distributions are among the best practices.

In the Project Based Learning Program for Nuclear Workforce Development at WCU, we incorporated these best practices as well as our expertise in project-based learning to recruit students into the Bachelor of Science in Engineering, Mechanical and Electrical Power concentrations.

III. Program Description

The Project Based Learning Program for Nuclear Workforce Development (PBLP4NWD) sought to engage scholarship recipients in a broad array of activities to enhance both their technical skills and facilitate the development of profession skills[14,15,16] over the course of the scholarship period. To this end, program participants were required to complete an interdisciplinary Project Based Learning (PBL) core of courses as well as five technical courses with a nuclear power emphasis.

Our PBL core presented the PBLP4NWD participants with the opportunity to learn and hone their professional "work ready" skills in an interdisciplinary learning environment. Course activities were focused on project management, teaming, problem solving, and written/oral communication skills development. The sequence of PBL course offerings were as follows:

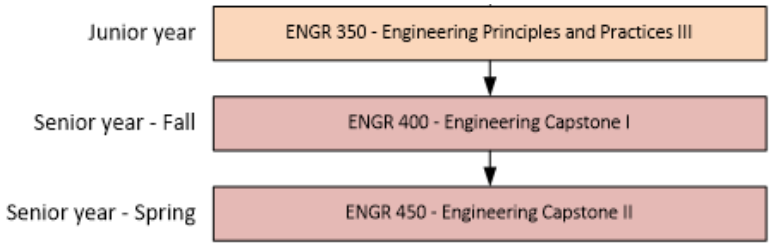

Figure 1: Project Based Learning Core of Courses

By starting in the Junior year and culminating with a year-long senior capstone, participants were able to progressively build their professional skills over several semesters. Detail PBL course descriptions may be found after the following titles:

> ENGR 350 - Engineering Practices and Principles III - Engineering project-based learning (open-ended) with emphasis on project control and engineering design processes. Special emphasis will be placed on professional, ethical, global, environmental, and contemporary issues. Contact Hours: 2 Lecture, 2 Lab.

ENGR 400 - Engineering Capstone I - Senior engineering project selection, planning, and development. Emphasis will be placed on defining project requirements, developing project work breakdown structure, conceptual designs, and working prototypes. 1 Lecture, 4 Lab.

ENGR 450 - Engineering Capstone II - Senior engineering project design, development, fabrication, and testing. Emphasis will be placed on iterative design processes, project management and execution, fabrication and testing. 1 Lecture, 4 Lab.

Within each PBL course and project, the PBLP4NWD directors worked closely with the lead professor at the Center for Rapid Product Realization, a University Center supported by the U.S. Economic Development Administration (EDA), in mentoring and matching potential course projects to the participants. The center has an established relationship with regional high-tech industry such as GE and Eaton corporation. Because the center is a university-based product development center that helps industry clients refine existing products, develop new products, and improve business practices, they were able to provide project leads and support for the PBLP4NWD participant teams. The projects sponsored by the regional industry were addressed by the participants while they gain hands-on engineering experience during the two-semester senior capstone project.

To further increase the participant technical knowledge, they were required to study our Nuclear Power emphasis, which includes the following courses: 1) ENGR493-01 Special Topics-Distance Course #1, 2) ENGR493-02 Special Topics-Distance Course #2 3) ENGR 352 Thermodynamics and Heat Transfer, 4) EE 451 Electric Power Systems, 5) EE 452 Electric Machines and Drives. The courses 3, 4 and 5 above are offered in classroom by our engineering program. In collaboration with the Nuclear Power Institute at Texas A&M University, courses 1 and 2 will be delivered online. With the advising faculty's guidance, students will select from these three: 1) Nuclear Power Plant Fundamentals, 2) Nuclear Power Plant Systems (Pressurized Water Reactors), 3) Nuclear Power Plant Systems (Boiling Water Reactors).

PBLP4NWD participant group meetings focused on institutional services, which included the Career Services Office and the Financial Aid Office. Each participant received career counseling, internships tips, job search practice, as well as information about financial aid and the scholarship process. Other student support services on campus were also utilized to help students succeed, including seminars on financial planning, time management, public speaking, technical writing, and tutoring. The directors additionally provided mentorship and help with drafting project reports, coordinating with the student support services key personnel, and ensuring that the scholars who were not performing adequately in their classes receive tutoring, coaching, and counseling as necessary to succeed.

The PBLP4NWD directors functioned as the participants' primary mentors. The directors also facilitated interaction of the Scholars with other students, faculty, and university programs that provided the participants with academic support and social benefit. The mentoring team participated in academic advising, social meetings of faculty and students, meetings of student organizations, career placement support, and meetings with industry professionals. In the event a PBLP4NWD participant did not maintain the requisite GPA, he or she was allowed one semester

to improve. During this probationary semester, the directors ensured the student received an extra measure of support and mentorship, including increased tutoring and mentorship through campus-wide opportunities through our student success offices. In the event a participant's efforts to remediate their GPA within the probationary period failed, the student was dropped from the program, and a suitable replacement was sought from the scholarship application pool of applicants.

During the initial and final stages of recruitment and orientation, the PBLP4NWD program made it clear to all participants that in the event an eligible student chooses to leave the EPE-ME programs, the student would be expected to follow the contract terms and pursue employment in nuclear fields for the duration agreed in the contract, based on the period of scholarship received. Students who did not comply with the terms of the agreement would be obliged to return the received scholarship funds to the university.

IV. Outreach and Recruiting Activities

PBLP4NWD Program is expected to play an integral part in WCU's recruitment activities for the expansion of the national nuclear-related workforce. Members of WCU School of Engineering + Technology along with the university as a whole engage in an active many-pronged recruitment program. The recruitment program includes taking trips to regional high schools and community colleges, drawing upon the school's service course base to recruit from within and outside the university, providing tours to high school students, and engaging in other activities that enhance the recognition of the program both within the community and throughout the region.

To this extent, comprehensive electronic and printed marketing as well as application materials such as a flyer and world wide web page were designed with the help of WCU staff. The following lists the recruiting and marketing activities in the Spring 2017 and Fall 2017 semesters for two different recruiting cycles:

- A world wide web page was established (http://nrcscholarship.wcu.edu).
- Various community colleges across the state including an early college were visited, flyers as well as application forms were distributed, and informative presentations were conducted.
- Four different sophomore and junior level engineering classrooms at WCU were visited and informative presentations were conducted.
- WCU Open House (4 times a year) is a campus preview program, designed especially for prospective undergraduate students to learn about the robust student life of a WCU student. In this program, the students were also introduced with various financial assistance opportunities. NRC Scholarship flyers during these events were distributed and the program was introduced to interested parties.
- Admitted students (especially transfer students) to our engineering program with Electric Power and Mechanical concentration were also informed through email about the scholarship opportunity.
- College office's email announcements were sent to all engineering students.
- Community College Forums were attended in October 2016 and interested parties were informed about the scholarship opportunity

- Representatives from a local nuclear industry were brought in to provide an informative presentation in a junior/senior level engineering classroom.
- The scholarship availability was announced to the related university offices including admissions and financial aid. These offices are generally the first points of contact for incoming students.
- One-on-one outreach effort to students/advisees who are potentially interested in the scholarship was conducted.
- Fall 2017 North Carolina Engineering Pathways meeting at Blue Ridge Community College was attended, an informative presentation was conducted.
- Email announcements were sent to student engineering organizations in campus such as IEEE and ASME.

In addition to the recruiting activities listed, application assistance workshops were held on March 2017 and October 2017 ahead of the application due dates for the purpose of streamlining the application process. Four potential applicants in the first cycle and three potential applicants in the second cycle attended these events. Attendees were mostly existing students majoring in Engineering program with Electric Power and Mechanical concentrations. There was one community college student who was interested to apply in future cycles. The workshop activities were:

- A presentation of scholarship details and requirements
- A question and answer session
- One by one analysis of application materials such as application form, letter of intent and transcripts.

All six existing students who attended these workshops eventually completed and turned in their applications. The community college student had an intention to apply, but his application did not materialize.

After months of effort, a total of six applications were received by the April 3rd, 2017 deadline in the first cycle. As a result of the relatively small applicant pool and associated awardees, a second round of outreach and recruiting efforts were conducted and primarily focused on internal students within the School. This effort yielded another six applications by the November 3rd, 2017 deadline.

The most effective activities with highest yield of return to date was determined to be engineering classroom visits by project investigators and one-on-one outreach effort to students/advisees who were potentially interested in the scholarship.

V. Applicant Evaluation and Selection Process

After the application packages were obtained, a committee of six, composed of three project investigators, the engineering program coordinator, and two industry/advisory board representatives, evaluated the applicants based on the established criteria. The selection criteria included: academic strength; letters of recommendation; engagement level at extracurricular and volunteer activities; and a resume along with an essay, which demonstrated the student's writing skills as well as his/her interest in participating in the nuclear related workforce after graduation.

Students from underrepresented groups in engineering, higher academic levels (i.e. junior and senior), and students with financial need were also assigned additional points in the ranking process. A candidate's ability to meet scholarship criteria and potential for success was another evaluation point that was determined through the professional discretion of the committee members. Each committee members' rankings were weighed equally to determine the overall student ranking.

In the Spring 2017 cycle, a total of 6 application packages were received from the candidates. One applicant was not eligible since he was an incoming freshman. Four applications were from existing students and one was from an incoming community college transfer student. In terms of demographics, there were one Hispanic, one African American, four White Non-Hispanic, one Female and five Male applicants. Table 1 summarizes the evaluation matrix used in the selection process.

Table 1. Rubric used in the NRC scholarship recipient selection process

Selection Criterion	Point Range	Description
Essay and Resume	0 to 9	Application essay and resume quality that highlights students interest
Recommendation Letters	0 to 9	Strength of support and confidence on student's success
Extracurricular and Volunteer Activities	0 to 9	Applicant's level of commitment towards success and common good
Academic Strength	0 to 9	GPA, standardized test scores and class rank
Miscellaneous	-2 to 2	From underrepresented groups, higher academic levels, financial need status, professional discretion
TOTAL MAXIMUM	**38**	

With the professional discretion criterion, for example: if a student was qualified for all 4 categories, then he/she received a 2, whereas, if a student was qualified for just 1 category, then he/she received an -1. There was a total of 36 points-based ranking where miscellaneous criterion was used as a tie breaker. The committee had several meetings to review the applications. Once the ranking was completed, the top three students who clearly set themselves apart from the other candidates were notified by two project investigators through email with scholarship acceptance and agreement packages. Students were given two weeks to respond where all three students accepted the scholarship. In the first implementation of the NRC Scholarship program, the recipients included three existing university students who were in Junior standing. In terms of gender distribution, one awardee was a Female student and two were Male students. In addition, one was a Hispanic student and two were White Non-Hispanic students.

In the Fall 2017 recruiting cycle, a total of 6 application packages were received from the candidates. Five applications were from existing students and one was from an incoming community college transfer student. In terms of demographics, there were one Asian, five White Non-Hispanic, two Female and four Male applicants. After the completion of applications, a scholarship screening and selection committee was formed. The committee included the PI and two Co-PIs as well as the engineering program coordinator and two industry/advisory board

representatives. Identical rubric, as shown in Table 1, was again used for evaluation of candidates. Once the ranking was completed, the top four students (due to the availability in the budget) were notified by the project's Co-PI and PI through emails containing the scholarship acceptance and agreement packages. Recipients were given two weeks to respond. All four students accepted the scholarship. In this cycle, one awardee was a Female and three were Male students. All four students were White Non-Hispanic. The selection results for ethnicity in both recruiting cycles combined compare well with the general population composition. The selection results for NRC scholarship includes one ethnically diverse student out of the seven selected i.e. ~14%. This ratio for the general student population composition as of spring 2018 semester is slightly below 13%.

VI. End of First Semester Evaluation Results

The first common semester for all seven awardees was Spring 2018. The evaluation activity was conducted through surveys of the award candidates and a sampling of other existing students in the engineering program with electric power (EPE) and mechanical (ME) concentrations at WCU. These surveys were distributed in four different classrooms and had a total 34 responders, including the seven scholarship recipients. The following charts and analyses show the survey results conducted in this semester in relationship to the recruiting and application process.

Associated survey questions were:

1. The application process for NRC was easy for me to complete.
2. The expectation for NRC scholars to maintain at least a 3.0 GPA overall within major is reasonable.
3. The funding provided by my NRC scholarship is important to my being able to pursue my degree.
4. I believe it is important for me to participate in NRC activities focused on recruitment of new students.
5. How did you learn about the NRC Scholarship project?
6. How could the recruitment and application process for new NRC scholars be improved?
7. How could the NRC scholarship project be improved?

The first four questions were Likert-type and the remaining three questions were open-ended. The following analysis summarizes the survey results for these questions for two groups (with or without NRC scholarship recipients) in four courses, including three junior and one senior level course:

> **Group 1:** ENGR 353 – Thermodynamics class and an independent student survey; n = 23; Number of NRC scholarship recipients = 7.
> **Group 2:** ENGR 315 – Electrical Engineering Fundamentals, ENGR 450 – Engineering Capstone II and ME 332 – Heat Transfer: Analysis and Applications classes; n = 11; Number of NRC scholarship recipients = 0.

Question #1: For Group 1, 6 out of 22 students strongly agreed or agreed that the application process for the NRC scholarships was easy to complete. 1 student disagreed, and 15 students stated, 'not applicable' and 1 remained 'neutral' perhaps indicating that he/she did not apply for the NRC scholarships. For Group 2, all students indicated 'not applicable' (11), suggesting they

did not apply for the NRC scholarships. In summary, 7 out of 8 (88%) respondents gave positive response. Figure 1 shows the details of the survey results to this question for all groups combined excluding 'not applicable' responses.

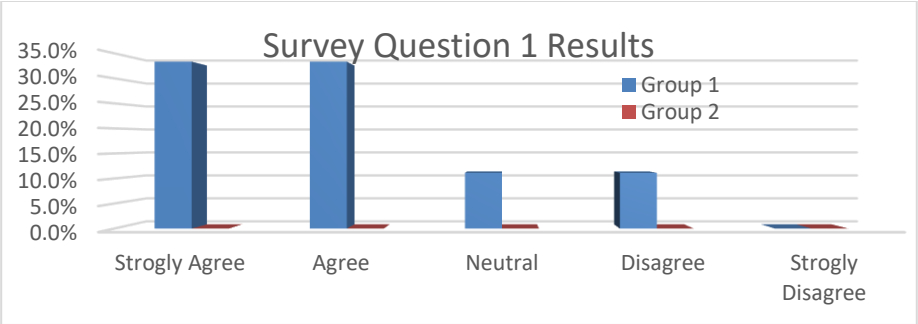

Figure 1. Responses to Survey Question 1. "The application process for NRC was easy for me to complete"

Question #2: In both groups, most of the students strongly agreed or agreed that maintaining a GPA of 3.0 overall and within major was reasonable to keep the scholarship. Figure 2 shows the details of the survey results to this question for both groups.

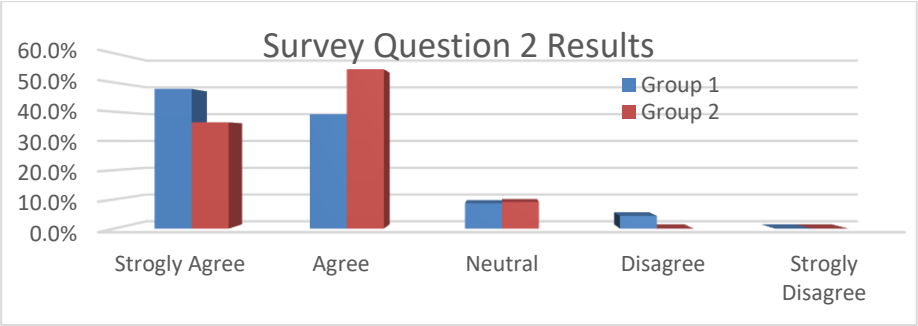

Figure 2. Responses to Survey Question 2. "The expectation for NRC scholars to maintain at least a 3.0 GPA overall within major is reasonable"

Question #3: In Group 1, there were seven students receiving NRC scholarship. 100% strongly agreed or agreed that funding provided by NRC is important for pursuing a degree in engineering. The remaining students responded that this did not apply to them suggesting that they did not receive the scholarship. In Group 2, no student was a recipient of an NRC scholarship. Therefore, all stated that this question did not apply to them, since they did not have an NRC scholarship. Figure 3 shows the details of the survey results to this question for both groups excluding 'not applicable' responses.

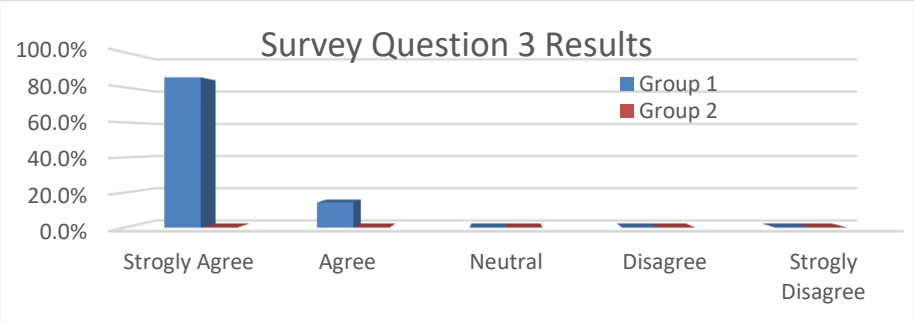

Figure 3. Responses to Survey Question 3. "The funding provided by my NRC scholarship is important to my being able to pursue my degree"

Question #4: In the fourth question, the students were asked the importance of participating in NRC activities focused on recruitment of new students. In Group 1, 5 out of 23 (22%) strongly agreed or agreed that it was important for students to participate in activities focused on recruitment of new students. 18 out of 23 (78%) students were either neutral (6) or stated, 'not applicable' (12) indicating this question did not apply to them, since they were not either NRC scholarship recipients or they were not really interested. Similar results were observed in Group 2. 4 out of 11 students agreed (36%) with the statement in Question 4, while the rest of the students (64%) remained neutral (1) or indicated this question did not apply to them (6). It was interesting to see that some of the students in Group 2, that are not NRC scholarship recipients, showed interest in participating in recruiting activities. This result can be attributed to the students' interest in the field and/or their spirit of volunteerism. Figure 4 shows the details of the survey results to this question for both groups.

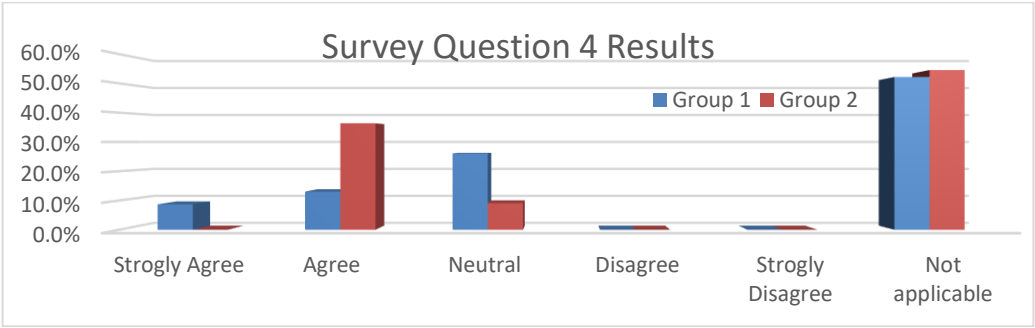

Figure 4. Responses to Survey Question 4. "I believe it is important for me to participate in NRC activities focused on recruitment of new students"

Question #5: When students asked about the way they learned about the NRC Scholarship project, the answers from NRC scholarship recipients included 'project investigator's class visits/announcements' and/or 'faculty adviser/mentor' (6), 'flyer' (1). The responds from other students in Group 1 include 'flyer' (2), 'project investigator's class visits/announcements' and/or 'faculty adviser/mentor' (8), peers (1). In Group 2, the responds include 'flyer' (2), 'project investigator's class visits/announcements' and/or 'faculty adviser/mentor' (2), 'peers' (1), 'college email announcement' (1). Some students did not respond as they have never heard of this

scholarship program until this survey. Among 24 respondents, 'project investigator's class visits/announcements' and/or 'faculty adviser/mentor' were the best ways of getting the word out with 16 responses, 'flyer' was the second with 5 responses, 'peers' was the third with 2 responses and 'college email announcement' was the last with 1 response.

Question #6: Suggested improvement methods by participants in Group 1 for the recruitment and application process for new NRC scholars include:

1. Introducing more students to the majors offered and scholarships that would support them
2. Announcements in first year seminar classes for freshmen and/or sophomore students
3. More aggressive advertisement
4. Clarification of nuclear-related service obligation of the scholarship, which can make students discouraged to apply
5. Involving student engineering organizations
6. Outlining deadlines and clarification of application requirements

Unique suggestions from Group 2 survey participants are:

1. Outreach to WCU Biltmore instructional site for engineering program
2. Social media
3. Early announcement (e.g. through sophomore level project-based learning courses)

Application process related improvement suggestions can be noticed from 4^{th} and 5^{th} items in mentioned by Group 1 participants. The rest of the suggestions were related to the recruitment process. Some of the recruiting suggestions above, such as involvement of student engineering organizations, have already been explored, but more intensive outreach was the focus of these types of statements. Only suggestion 3, from Group 1, was repeated by a few other participants. The other suggestions were specific to individual participants.

Question #7: General suggestions regarding the improvement of the NRC scholarship project were the focus of this question. Only a few applicable suggestions were indicated by both groups:

1. Explaining/communicating requirements of scholarship clearly such as the additional nuclear courses and their scheduling information
2. More incentive and more recipients
3. Targeting more transfer students and women, especially the ones that need to commute longer distances

These suggestions came from 3 out of 34 total participants. Other than the first suggestion, the next two were from two participants that are not the recipients of NRC scholarship. Application assistance workshops were specifically designed to address the concern, posed by the first participant. However, more can still be done to clarify these requirements.

The survey involving students who are not part of the program was important to show student opinions on the significance of the nuclear-related workforce development program and initiative, as well as scholarships to pursue this program. In addition, surveying students who are not part of the program was expected to help identify potential differences and similarities of opinion among the surveyed students. Significance of the program is apparent from the collected responses.

VII. Conclusions

The primary goal of this paper is to disseminate the knowledge in developing an educational / support program to promote education and awareness in nuclear related fields to assist the nuclear workforce pipeline. The literature makes it clear that there will be a need for skilled workers in the nuclear related fields in the near future. The universities are responsible for preparing students for positions in these fields; however, the role of universities and educators is shifting from just education to include recruitment and retention efforts as well. In this paper a multi-faceted recruitment and related activities engaged in at WCU, through the support of NRC, has been presented that aims to alleviate shortages in the workforce in nuclear-related fields. WCU has adopted an electric power concentration in its Engineering program and delivers sustainable power related courses. The courses offered through this concentration that are available to the scholarship recipients are designed to serve sustainable as well as conventional power related career opportunities. Therefore, students in this scholarship program are projected to be competitive in pursuit of their careers if the nuclear energy renaissance continues to be elusive. In addition, through collaboration with NPI, WCU offers distance courses in nuclear power to support the foreseen needs of the nuclear and power industry.

PBLP4NWD is a two-year program that funded seven nuclear workforce development scholarships for specially selected and highly motivated electric power and mechanical engineering students, who are pursuing an educational emphasis in nuclear power and who desire to contribute to the nuclear-related national workforce. The program's main objective is to prepare these scholars for serving nuclear-related industry and academia through WCU's engineering project-based learning sequence. The program's secondary objective is to increase the quantity and diversity of the engineering programs and workforce. As part of outreach and recruitment efforts, PBLP4NWD program aimed at community college transfer students as well as existing students demonstrated the success of this endeavor. The survey results and follow-ups conducted through scholarship recipients in the first semester revealed that the scholarship is a valuable tool for educating the next generation of power professionals. The effect of the first-year activities of this scholarship program will most likely take some time to reveal; however, the preliminary information supports the importance of scholarships to encourage and draw students to nuclear power and related fields as well as help them succeed in their selected curricula.

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Bibliography

1. Aston, A. (2007). Who Will Run the Plants? BusinessWeek, (4018), 78.

2. Wheeler, B. (2011). Nuclear Workforce: Refueling for a New Generation. Power Engineering, 115(6), 38.

3. Anticipating Demand, Colleges Revive Dormant Nuclear Ed Programs. (2009). Community College Week, 21(11), 3.

4. Education programs help fill jobs pipeline. (2014). Business North Carolina, 34, 24.

5. Columbia Energy Exchange, host Bill Loveless; (January 7, 2019) Maria Korsnick: The Outlook for Nuclear Energy in U.S. Preserve Nuclear Plants. Retrieved from https://nei.org/news/2019/ceo-outlook-for-nuclear-energy-in-us

6. Fuel Security, Analyzing Fuel Supply Resilience in the PJM Region (2018) Retrieved from https://www.pjm.com/-/media/committees-groups/committees/mrc/20181101-fuel-security/20181101-pjm-fuel-security-summary.ashx

7. Bipartisan Bill Aims to Boost U.S. Nuclear Industry (October 2018), Nuclear News, 39.

8. Thaddeus Swanek, (January 16, 2019), President Signs Bipartisan Bill to Modernize Nuclear Regulation, NEI News.

9. Establishing a Culture of Continuous Learning and Improvement. (2019). Power, N.PAG.

10. American Nuclear Society, (October 2018), Navigating Nuclear: Energizing Our World™, retrieved from http://www.ans.org/pi/navigatingnuclear/

11. C. E. Davis, M. B. Yeary and J. J. Sluss, "Reversing the Trend of Engineering Enrollment Declines with Innovative Outreach, Recruiting, and Retention Programs," IEEE Transactions on Education, vol. 55, no. 2, pp. 157-163, May 2012.

12. Deveau, D. (2013, May 07). Seeking a fresh start; engineering program recruitment. National Post.

13. Thompson, A. McGraw, C., & Hair, S. (2015) Making it work: Gainful engineering education and recruitment through industry engagement. ASEE Southeastern, Conference Proceedings, University of Florida, Gainesville, FL.

14. Walther, J., Kellam, N., Sochacka, N. and Radcliffe, D. (2011). "Engineering Competence? An Interpretive Investigation of Engineering Students' Professional Formation." Journal of Engineering Education, 100(4), pp. 703-740.

15. Jollands, M., Jolly, L., and Molyneaux, T. (2012). "Project-based Learning as a Contributing Factor to Graduates' Work Readiness." European Journal of Engineering Education, 37(2), pp. 143-154.

16. Klein, B.D., Davis, T.A. and Kridli, G. (2015). "Building a Rube Goldberg Machine in an Undergraduate Business School Course to Learn Principles of Project Management and Leadership Skills." Journal of the Midwest Association for Information Systems, 2015(2), pp. 53-66.