Recruitment and retention of active duty/transitioning military personnel and veterans in STEM through workshops

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Abstract

Faculty from East Carolina University (ECU), Wilson Community College (WCC) and Craven Community College (CCC) collaborated to conduct one-day pilot workshops on 3D printing (3DP) and Solar Energy (SE) in Spring 2018 for veterans and active duty/transitioning military personnel holding several Military Occupational Specialty codes. The team hypothesized that by providing an interactive, exploratory educational environment in the form of workshops, an increase in awareness about career pathways/opportunities in STEM fields such as SE and 3DP could be achieved which could then lead to an increase in the recruitment and retention of military personnel and veterans in STEM. Activities in the workshops included hands-on experiments, lecture sessions and interactive Q&A sessions. Information about important professional certifications in SE and 3DP was also provided during the lectures. Data from exit surveys demonstrated that the participants obtained important technical and career information about SE and 3DP, and, hence were more willing to pursue STEM degrees through two/four-year colleges.

Keywords

Active duty/transitioning military personnel, veterans, solar energy, 3D printing, STEM workshop.

Introduction

The economic impact of Solar Energy (SE) technology and 3D Printing (3DP) is estimated to be about $1.2 trillion by 2025[1]. Since 2013, according to the Solar Foundation report[2], "National Solar Jobs Census 2017", the SE sector has grown at an annual rate of 16% and added about 131,000 new jobs. According to the North Carolina Department of Commerce[3], the state of North Carolina is expected to see an average annual growth of 2.6% in the energy and technology sector. For a sector already ranked in the top 3 for higher growth rates, this considerable growth rate increase translates to more than 57,000 additional jobs (or a 10% increase in jobs) by 2022[3].

Projections of job growth for 3DP, based on the A.T. Kearney Holdings report[4], is about 3-5 million skilled jobs in the US by 2030. With recent advances in printable materials for 3DP, increased accessibility and affordability, this technology has found more applications in numerous industries. Products such as 3D printed houses, cars and prosthetics have gained worldwide attention due to their ease of production and high utility value[4]. Also, 3D printing has found applications in Rapid prototyping and printing of replacement parts for critical components[5]. Numerous educational institutions across the US have already begun the process of integrating 3DP into their labs and academic courses[5].

The reason for using workshops to affect retention and recruitment rates was based on available literature exploring the effectiveness and impact of workshops on students and professionals alike[6-11]. R.W. Preszler[7] demonstrated that workshops were helpful in increasing retention rates amongst males, females and underrepresented minority students. The same study reports that interactive workshops also improved the quality of student learning and engagement[7]. L.T. Tien, et al.[8] show that workshop sessions are closer to students' zone of proximal development and region of students' potential knowledge gain and can result in enhanced learning. One of the key benefits of a workshop is that they also provide a learning environment that promotes communication and cooperative learning among the participants[10,11].

Based on the aforementioned details, faculty from ECU, WCC and CCC collaborated to conduct, two, one-day workshops aimed at increasing the career awareness surrounding SE and 3DP among active-duty/transitioning military personnel and veterans – population that continues to make significant contributions to the collection of engineers and engineering entrepreneurs over several decades[12-14]. The workshops were purposely kept interactive and exploratory, as it was hypothesized that such an environment would better affect the retention and recruitment rates of military personnel and veterans in STEM fields like SE and 3DP. More emphasis was placed on hands-on activities and informal small-group discussions. Workshop participants were either enlisted active duty/transitioning military personnel or veterans with various Military Occupational Specialty (MOS) codes such as Motor Vehicle Operator, Basic Utilities, Field Radio Operator and Basic Musician etc. Some of the MOS codes belong to the STEM category while some were in the non-STEM category.

Methodology and structure of the SE and 3DP workshops

The workshops were designed to provide participants with an interactive, informal, exploratory educational environment. To seek participants, information about the workshops were advertised at the Marine Corps Air Station (MCAS), Cherry Point, NC by faculty from CCC. The workshops began with an informal lecture session where the participants were provided relevant technical information about the topic. Figure 1 shows the lecture session for the SE workshop collaboratively conducted by faculty from ECU and WCC.

Figure 1: Informal lecture session for the SE workshop

After a short break, information about career pathways and technical/professional certifications available in SE and 3DP were provided to participants. Projections in job growth and the average starting salaries in these fields were given. The required educational degrees/levels to enter the job market in SE and 3DP were also provided. Lecture notes consisting of all these details were given to the participants at the beginning of the session.

This was followed by hands-on activities/experiments session where the participants could work individually or in small groups. Depending on the workshop, an expert in SE or 3DP would lead this session and answer any questions/queries the participants might have about the experiments. The expert was a faculty member from one of the participating institutions. The activities/experiments chosen clearly showed key fundamental/operating principles of SE or 3DP during these sessions. Also, while conducting experiments, the participants were encouraged to leverage technical knowledge gained in the lecture session. These activities allowed the participants to get a closer look at key equipment such as flexible solar panels, 3D printers, solar irradiation sensors, filament spools for 3D printers and components of a residential solar unit etc. A document containing details about the experiments/hands-on activities were provided to the participants. Figure 2 shows an experiment session during the SE workshop.

Figure 2: Hands on activities/experiment session for the SE workshop

Particularly for the 3DP workshop, participants were given a detailed account of the 3D modeling software such as SolidWorks and Fusion 360. A document containing a step-by-step procedure for 3D modeling of a simple geometric object was provided. The participants were then provided with a lecture on how to use a 3D printer such as the MakerBot®. Figures 3a & 3b show the session on 3D modeling software and the MakerBot space used for 3D printing.

(a)

(b)

Figure 3: Session on 3D modeling software and MakerBot space for 3D printing

Faculty from ECU and WCC collaboratively conducted the 3DP workshop. After the completion of the workshop, an exit survey consisting of seven questions was provided to all the participants. Participation in the survey was voluntary. Faculty from ECU, WCC and CCC designed the survey questions. Figure 4 given below shows a schematic for the SE & 3DP workshops. The participants generally spent about 7 hours in each workshop. Results from the survey are discussed in the following section.

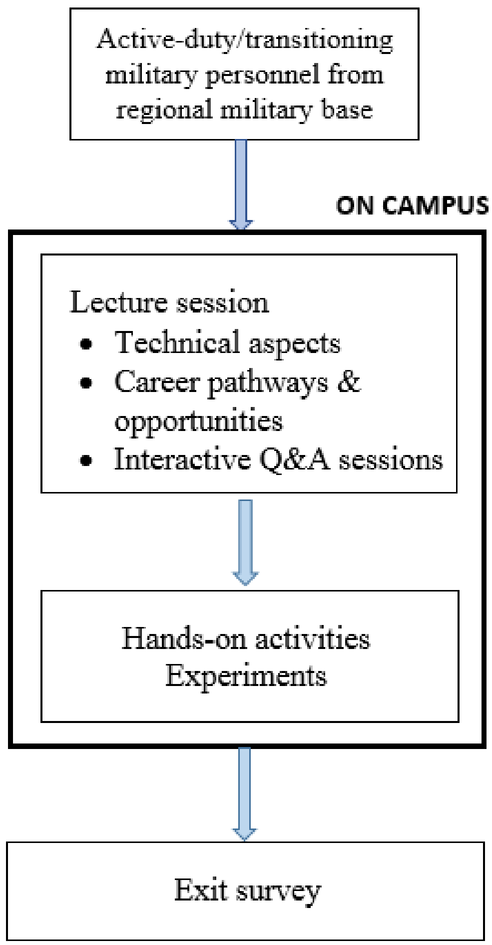

Figure 4: Schematic for the SE and 3DP workshops

Results from the SE & 3DP Workshop survey

Participants were provided with an exit survey to solicit their opinions about various aspects of the workshop. The survey results were used to gauge the effectiveness of the SE and 3DP workshops in increasing technical awareness, gaining knowledge about important fundamental/operating principles and providing information about career opportunities & pathways. A survey form consisting of seven questions was developed and administered after the completion of the workshop. There were 8 participants in the SE workshop and 11 participants in the 3DP workshop. The responses were assigned numerical values on the Likert scale of 5 to 1 with 5 corresponding to “strongly agree,” 4 to “agree,” 3 to “neutral,” 2 to “disagree” and 1 to “strongly disagree.” The survey questions and corresponding responses are shown in tables 1 and 2 on the next page.

Table 1: Likert survey results for the SE workshop

No	Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Average Response
1	The objective and activities of the workshop were clearly defined	5	2	0	0	1	4.25
2	The activities in the workshop helped me gain knowledge about the working principles of a residential solar photovoltaic system	6	2	0	0	0	4.75
3	The activities in the workshop increased my awareness about the different components of a typical residential photovoltaic system	5	3	0	0	0	4.63
4	The activities in the workshop provided me with technical knowledge about assessing the performance of a typical residential photovoltaic system	5	3	0	0	0	4.63
5	The workshop enhanced my awareness about career possibilities in solar energy sector	6	2	0	0	0	4.75
6	The workshop made me aware of the broader career opportunities in the renewable energy area	6	2	0	0	0	4.75
7	The career pathways given on renewable energy technology were clear and well defined	6	2	0	0	0	4.75

Table 2: Likert survey results for the 3DP workshop

No	Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Average Response
1	The objective and activities of the workshop were clearly defined	8	3	0	0	0	4.73
2	The activities in the workshop helped me gain knowledge about the working principles of a 3D printer	10	1	0	0	0	4.91
3	The activities in the workshop helped me gain knowledge about the different components of a 3D printer	9	1	1	0	0	4.73
4	The activities in the workshop helped me gain knowledge about the different components of a 3D modeling software	8	3	0	0	0	4.73
5	The activities in the workshop helped me gain knowledge about the different steps involved in a 3D printing process	10	1	0	0	0	4.91
6	The workshop helped me better appreciate the usefulness of 3D printing	10	1	0	0	0	4.91
7	The workshop made me aware of the career opportunities in the additive manufacturing sector	9	2	0	0	0	4.82

The averages of all responses for each question are given in the last column of Table 1 and 2 along with the frequency distribution. The average of all questions for the SE workshop (Table 1) is 4.64 and the average of all questions for the 3DP workshop (Table 2) is 4.82. These averages indicate that the participants are generally in agreement that the SE and 3DP workshops increased their technical awareness, helped gain knowledge about key operating principles and provided information about career opportunities and pathways.

Participants were also requested to provide any feedback or suggestions about improving the workshops. The feedback showed that participants were interested in leveraging the knowledge gained in these workshops to obtain professional/technician certification in SE and 3DP, as well as pursuing an advanced degree in regional and local educational institutions. Regarding career pathways, one of the participants commented, “[It] made me change my options for a career path” indicating that the workshop helped increase awareness about career pathways in SE and 3DP. The feedback will be used to make improvements to the structure and content of future workshops, thus, increasing its effectiveness and ability to adapt to the changing market needs and trends both nationally and regionally.

Conclusion

Workshops on nationally relevant themes of SE and 3DP were conducted collaboratively by ECU, WCC and CCC located in North Carolina for active duty/transitioning military personnel and veterans. In these one-day workshops, participants were given an opportunity to learn about SE and 3DP through informal lectures, interactive Q&A sessions and hands-on activities/experiments. Additionally, a session on career pathways and opportunities in SE & 3DP was also provided. There were 11 participants in the 3DP workshop and 8 participants in the SE workshop. To determine the workshop’s effectiveness, a post survey consisting of seven questions was administered to the participants in each of the workshops. A request to provide feedback or suggestions to improve the workshops was also made. Participant’s responses to the survey questions were assigned numerical values on the Likert scale of 5 to 1. Using these values and the corresponding frequency distribution, the average values for the SE and 3DP workshops were found to be 4.64 and 4.82, respectively. These values indicate that by participating in these workshops, active duty/transitioning military personnel and veterans were able to gain technical awareness, knowledge about operating principles, information about technical/professional certifications and information about career opportunities in the SE and 3DP sectors. Some of the comments received as part of the feedback showed that participants became more aware about career opportunities in SE and 3DP and were, therefore, open to the possibility of pursuing two/four-year STEM degrees in regional and local educational institutions. For future workshops, the suggestions received as part of the survey will be used to make improvements to both the delivery and structure of the workshops. Specifically, the workshops will be conducted over two days and a visit to an actual site or installation will be planned. The site visit will be planned such that the participants can have an opportunity to interact with industry professionals working at the site.

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Biographical Information

Praveen Malali

Praveen is the Director of Research at the Center for Sustainable Energy and Environmental Engineering (CSE3) at ECU. His research interests include engineering education, veterans in STEM, fluid mechanics, sustainable energy and engineering. He has experience tutoring transitioning veterans in STEM and has taught courses such as dynamics, thermodynamics, fluid mechanics and statics.

Faete "JT" Filho

JT is currently an assistant professor in the engineering department at ECU working in the areas of renewable energy, power systems, power electronics and machine learning. His current areas of interest include multilevel inverters, power converters for distributed energy resources, and artificial intelligence techniques and applications to power conversion.

Joshua Stevens

Joshua is an Applied Engineering Technology Instructor at WCC. He has a passion working with applications of additive manufacturing within the workforce and educational background. He

likes taking the time to acquire the best technique to educate individuals in a method that is easier for them to understand. Additionally, he is the current Vice President of the ATMAE student division, helping student network and apply their skills to the workforce.

Daniel Dickerson

Daniel is a Professor of Science Education in the Department of Mathematics, Science, and Instructional Technology Education, Coordinator of the STEM CoRE (Collaborative for Research in Education) at ECU, and Co-Director of ECU's pan-institutional STEAM Education Research Cluster. His research focuses on the teaching and learning of earth and environmental science content, environmental education, and STEM instruction. He has served as PI, Co-PI, or Evaluator on NOAA, NSF, NIH, US Department of Education and state funded projects.

James Menke

James is the Director, of National Security Initiatives at ECU. He is a retired U.S. Navy Master Chief with more than 30-years of Naval service. He holds both a bachelors and master's degrees in Health Sciences from Trident University International. His passion is to mentor both ECU students and transitioning military service members as they prepare themselves to enter the future workforce.

Kim Zaccardelli

Kim is currently the Coordinator of Workforce Development & Military Programs for CCC and works aboard the Havelock campus which is situated outside the gate of Marine Corps Air Station Cherry Point. She is dedicated to helping students achieve their goals and dreams and assists young men and women in determining where their passions lie and what career path they should pursue. She is a certified Program Manager by the LERN organization and she is a certified instructor for Development Dimensions International.

Robin Matthews

Robin is the Dean of Workforce Development at CCC. He is a retired Chief Warrant Officer from the United States Marine Corps with more than 30 years of leadership and technical experience. He holds a Lean Six-Sigma Green Belt Certification from General Electric and is a Certified Program Manager by the LERN organization. He is passionate about helping match people to skills and careers through education and training to obtain licensure, credentials or hands-on training.

Gery Boucher

Gery is the Vice President for Students at CCC. He has worked for CCC for 18 years. He worked 3 years as the Education Branch Manager for Marine Corps Camp Lejeune. He has served as a Swansboro Town Commissioner from 2011-2015. He is a National Certified Counselor and holds a certification as a Global Career Development Facilitator.