2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
ASEE
Paper ID #38536

Work in Progress: How to Get Faculty to Use and Leverage Makerspaces in Their Courses — A Peer-To-Peer Mentoring Model

Dr. Maria-Isabel Carnasciali, University of New Haven

Maria-Isabel Carnasciali is an Assistant Provost for Assessment and Faculty Development at the University of New Haven, CT. She is also a Professor of Mechanical Engineering in the Department of Mechanical and Industrial Engineering.

Enakshie Prasad
Eric Marcus, University of New Haven
Dr. Stephanie M. Gillespie, University of New Haven

Stephanie Gillespie is the Associate Dean of the Tagliatela College of Engineering at the University of New Haven. She previously specialized in service learning while co-directing the Engineering Projects in Community Service program at the Arizona State University. Her current research interests include engineering student identity, makerspaces as teaching resources, and entrepreneurial mindset. She continues to teach first-year engineering courses and supports students through mentorship and student organizations. She completed her PhD in Electrical and Computer Engineering from Georgia Tech.

Joseph Smolinski

WIP: How to get faculty to use and leverage makerspaces in their courses – a peer-to-peer mentoring model.

In this work-in-progress paper, we describe our efforts to implement a coach and peer-to-peer mentoring model to provide structured faculty development in entrepreneurial mindset (EM) integration through makerspaces.

As faculty members try to innovate and update their classes, a recent merger of the Maker movement and the Entrepreneurial Mindset (EM) movement has provided specific training and opportunities to revitalize the engineering curriculum. Studies have suggested facilitating EM projects with the makerspace are excellent opportunities to develop student skills in areas related to entrepreneurial mindset such as opportunity recognition, learning from failure, stakeholder engagement, and value creation [1, 2]. While makerspaces are a proven conduit for EM, they are not instantly accessible to many faculty due to a lack of prior exposure or training. Faculty are typically experts in their technical discipline, and while some receive training in broad pedagogy, few receive training in either EM or makerspaces. The extensive new skills needed cannot be taught through a textbook, where faculty can stay a chapter ahead. Learning to successfully facilitate open-ended projects takes finesse and learning to safely use a laser cutter (*or any other makerspace-related equipment*) takes practice.

Based on social cognitive theory and anchored on peer-to-peer learning framework, our *mentoring* program focuses on three phases: prepare, engage, and apply [3]. Twelve faculty members, including 5 from the college of engineering, were selected to participate in a 2-year pilot program. As only a small number of faculty on the campus have experience in the makerspace, we did not designate an individual as the more experienced "mentor" in the relationship. Rather, all participants are considered learners, and were paired to a buddy (peer) to join for the mutual professional development experience. In this paper, we share the framework and structure for training and supporting the faculty. We conclude by reflecting on some early data and lessons learned, highlighting the specific experiences of the college of engineering faculty for this WIP.

Motivation for this study

The origins of makerspaces at colleges and universities can be traced back to the late 2000s, when a growing number of schools began to create dedicated spaces for students to engage in hands-on making, prototyping, and other forms of creative exploration. Since then, makerspaces have become increasingly common at colleges and universities around the world, as schools recognize the value of hands-on learning experiences for students and the importance of fostering a culture of innovation and entrepreneurship. Today, makerspaces can be found at a wide range of institutions, from large research universities to smaller liberal arts colleges.

While some faculty members may be familiar with the equipment in makerspaces and have experience using it, many others may be less familiar or have little experience with the tools. In general, colleges and universities are taking steps to support faculty members who are interested in incorporating makerspaces into their teaching. For example, some institutions have staff members who are responsible for managing the makerspace and providing support and training to faculty members. These staff members can serve as resources for faculty members who are interested in using the makerspace but are not sure how to get started. Other institutions offer training and professional development opportunities for faculty members, such as workshops on how to use specific tools and equipment, or mentorship programs that pair faculty members with experienced makerspace users.

The makerspace at the University of New Haven

At the University of New Haven, the campus-wide makerspace opened in Fall of 2020. The space is led by a faculty member who receives course release to oversee a cohort of student space assistants. At present time, there is no designated space technician, however, two other faculty members, vested in the success of the space, have provided additional support specifically for on boarding faculty to use the makerspace. Together, these three faculty members had prior experience with maker-like spaces and the types of equipment frequently found in makerspaces. Few others on campus expressed familiarity with the space or its equipment, and many stated not envisioning using it in support of their courses. To address this, several efforts have been rolled out to increase faculty familiarity and engagement with the makerspace [4]. However, the impact of direct mentorship-mentee setup is limited by the number of expert users, in this case, the three faculty members (a mechanical engineer, and electrical engineer, and an artist), and their available time to mentor other faculty. Our study was born out of a desire to quickly increase the number of faculty members who would be not only familiar with makerspace and comfortable working with the array of available equipment, but who could also fully integrate the use of the space into their courses.

Entrepreneurially Minded Learning & makerspaces

Entrepreneurially Minded Learning (EML) is about equipping engineering students to think like entrepreneurs, not necessarily to become entrepreneurs. The goal of EML is to help engineering students develop a specific way of thinking and approaching problem-solving that is characterized by curiosity, connections and a focus on creating value [5]. By cultivating an entrepreneurial mindset, engineering students can learn to be more creative, adaptable, and resilient in their professional and personal lives regardless of whether they choose to become entrepreneurs or intrapreneurs. Because of the seemingly natural overlap between makerspace skill development and EML, faculty development efforts that merge the two frameworks have been created. *B-FAB*, or the Bucknell Fabrication workshop, was a 3-day experience for faculty and staff to introduce makerspace equipment, discuss pedagogy, and plan for classroom implementation [6]. The Kern Engineering Entrepreneurial Network (KEEN) has offered the *Making with Purpose* Faculty development program as a 4-day event that focuses on EM faculty development through makerspace projects and pedagogy. This coming year it will be offering two variations of this workshop Making *with EM Across the Curriculum* and *MakerSpark: A framework for Developing EM Making Activities* [7].

Three existing training opportunities have been pursued at the University of New Haven. These efforts were detailed in a prior paper by the authors [4] and included faculty members participating in a community makerspace, workshops focused on the maker pedagogy, and equipment training sessions that includes hands-on practice on the machines. Unfortunately, these expert-led and coach-led workshops have not led to 100% adaptation of material to the faculty's repertoire. Though the faculty that participated in the self-guided exploration successfully leveraged the equipment for the creation of personal projects, few, if any integrated the utilization of the space into their courses. Of the faculty that participated in pedagogy-focused workshops and hands-on equipment trainings sessions, based on anecdotal feedback of the various trainings, participants struggled to develop mastery on the makerspace equipment in the short time span of the trainings. Those that have attended external trainings, report additional hurdles due to brand/model differences in the equipment on which they were trained versus what is available at the home institution.

Faculty participating in our study were asked to develop projects and course integrations that aim to develop some aspect(s) of students EM. The final deliverable, at the conclusion of the 2-year period, is the submission of an Engineering Unleashed Card [8]. These cards function as a combination of blog and resource-sharing website all in one page, documenting the course plans/activities with sufficient detail that other faculty could then take the plan/activity and modify it to fit and deploy it in their own courses.

Research on mentoring models for faculty development

There has been a growing body of research on the effectiveness of peer mentoring programs rooted in social cognitive theories and research on influence [9]. Social cognitive theory, SCT, (earlier called Social

Learning Theory) was developed in the 1960s by Albert Bandura. It developed to its current definition in 1986 and suggests that learning occurs in a social context due to a triadic reciprocal determination of the person, environment, and behavior [10]. In other words, learning is affected by cognitive, behavioral, and environmental factors. Bandura went on to posit that virtually all behavior can be learned by observing other people's behavior and its consequences.

Over the years, this theory has been used for the development of peer mentoring programs. Since behavior can be learnt through modeling and observation [11], mentoring programs have been developed for Junior Faculty [12], STEM undergraduate students [13], women faculty [14], doctors [15], and college students [16]. Peer mentoring matches mentors and mentees who are roughly equal in age, experience, and power for psychosocial support. In the context of SCT, peer mentoring can be seen as a tool for positive behavior change as individuals are able to learn directly from their peers in a supportive, collaborative environment that allows the individuals to share their experiences, and challenges to promote learning.

For instance, a peer-mentoring program targeting 104 junior faculty members in the Department of Pediatrics at Vanderbilt University, led to the participants reporting significant changes in their knowledge, skills, and abilities (KSAs) pertaining to professional development and networking, with an increased ability of scholarship, writing their career goals, and aligning their actions with their goals [12]. Similarly, another facilitated peer-mentoring program with women faculty members yielded positive impact on academic skills and manuscript writing [14]. Another research involving junior doctors found that peer mentoring promotes psychosocial well-being by helping build support structures, building a sense of community, and allowing the new interns navigate their professional environment.

Related to peer mentoring is the use of accountability partners as a way of generating motivation towards goal achievement [17, 18, 19]. Accountability partners are based on the idea that having a peer partner can influence one's commitment towards a personal goal. Peer effects have been found to positively influence our behavior – from productivity at work, to contributions to public goods. We are more familiar with them in the context of individuals developing commitment by joining self-help peer groups (eg, Alcoholics Anonymous, running clubs, savings groups) [20]. We apply this concept as a tool to increase accountability for planning, experimenting, and incorporating a makerspace project into faculty member's pedagogy and faculty member's motivation [21].

Hoping to find similar positive outcomes, this study employed a peer mentoring program rooted in Bandura's Social Cognitive Theory and research on influence to help promote faculty success, develop Entrepreneurial Mindset, and make the faculty comfortable using the Makerspace.

Project methodology

The first year of the study focused on the *engage* phase. In September 2021, faculty from across the colleges were invited to apply based on their interest to learn about the makerspace and potential to incorporate the use of the makerspace into their courses. Twelve faculty members were selected to participate in our program, including five individuals from the college of engineering. In October, we held a kick-off meeting to outline the project goals and expectations, and to provide an opportunity for them to get to know us and each other and discuss their aspirations for being engaged with the makerspace. To support their mutual learning experience, the faculty were paired up, and the pairs were encouraged to utilize the student staff in the makerspace and expert makerspace coaches for personal training and general support throughout the course of the study. During fall and spring of the first year of the program, several trainings were offered, opened primarily to the cohort of faculty participating in this program.

The data collection is ongoing. At the onset of the study, participants completed a pre-assessment focused on prior experience with equipment in makerspaces, prior experience with active/collaborative teaching, and self-reported ratings on various aspects of entrepreneurial mindset. The same assessment will be conducted at the wrap-up of the two-year program.

During spring 2022, the faculty pairs were expected to connect monthly to share ideas, provide feedback, and check-in on progress regarding their project. We asked them to respond to a simple monthly check-in form (i.e., short reflective prompts) available online in our Learning Management System.

During summer 2022, thanks to funding from the grant, a Makerspace student staff was available to help faculty who wanted to come in during the summer months to practice using the equipment. No data collection was conducted during that time.

The second year of our study has been focused on implementation of the faculty project ideas, leveraging the makerspace, into their courses. To check in on progress in the middle of the second year, one-on-one semi-structured interviews were carried out by a trained graduate student research assistant in November 2022. In these interviews, participants were asked questions similar to the monthly forms, but in interview format, to gather more qualitative responses about their progress, barriers to progress, and related questions.

Preliminary results

Our study was spread out over a two-year period with year one focused on engaging the faculty and building community and year two focused on deployment of their efforts into classroom activities. Final results are not yet available. What we know is somewhat anecdotal and preliminary. We can report that at least two faculty members (out of the cohort of twelve) deployed their projects during Spring 2022 in the first year of the program. At least four of the twelve participants actively brought their classes into the makerspace during this fall 2022 semester. Additionally, we have three faculty members working closely with makerspace student staff assistants iterating on their plans and designs. However, we are also aware that we have two faculty members that have had little to no engagement with the makerspace staff or the training/coaching sessions we have offered.

For this paper, we are focusing on the results obtained from the engineering faculty participating in this program. From online one-on-one zoom interviews, we were able to come across several interesting insights. The participants stated that the biggest outcome from this program was the support and training they received to learn about the equipment in the makerspace. One participant said, "Best part is the accessibility to Makerspace and the chance to implement hands-on learning for the students." Three out of the five engineering faculty participants have already implemented their Makerspace projects in the previous semesters and the remaining two are supposed to implement it this Spring semester. Some participants reported being satisfied with the relationships with their respective partners and appreciated the fact that their partner was from a different discipline as it allowed for more brainstorming and collaboration. For instance, one partner was reported as saying, "having a partner from a different field gives a fresh perspective." However, a few said that the accountability partners program would have been more successful if the partners were from the same or related fields.

Next steps

The study as its currently running functions as a pilot project. Faculty leading and participating have essentially volunteer for this effort (the minor stipends allocated serve as a recognition of their effort but are not necessarily seen as full compensation for their time/effort). It was important to involve faculty from all colleges on our campus so that we can showcase this effort to the University leadership and the college deans. Part of our internal goal was to build a cohort of experienced faculty who could then serve as mentors for future faculty enabling the effort to continue moving forward. At the conclusion of this Spring semester, we look forward to completing further analysis regarding the results of the peer-mentor approach as a faculty development model in a situation with limited "experts". We will assess not only the integration rate of the activities planned by the faculty into the student experience, but also their experience in the makerspace and their experience in the peer mentor model.

References

[1]. E. D. Kennedy, S. R. McMahon, and D. Reis, "Independence in the Making: Using Makerspace Experiences to Build Foundational Entrepreneurial Competencies," in Entrepreneurship Education and Pedagogy, Vol. 4(3) pp 549-563. 2021.

[2.] D. Jaiswal, "Pop-up Makerspace Module in Undergraduate Studies Inculcating Entrepreneurial Mindset," *2020 IEEE Frontiers in Education Conference (FIE)*, Uppsala, Sweden, 2020, pp. 1-5, doi: 10.1109/FIE44824.2020.9274002.

[3]. D. Reinhold, T. Patterson, and P. Hegel, Make Learning Stick Best Practices to Get the Most out of Leadership Development, *Center for Creative Leadership*, 2015.

[4]. M. I. Carnasciali, S. M. Gillespie and A. M. Hossain, "Integrating Makerspaces into the Curriculum – Faculty Development Efforts," 2021 IEEE Frontiers in Education Conference (FIE), Lincoln, NE, USA, 2021 , pp. 1-7, doi: I 0.1109/FTE49875.202 l.9637230.

[5]. The Framework for Entrepreneurially Minded Learning, Engineering Unleashed, Accessed on February 2023. [Online]. Available: https://engineeringunleashed.com/framework.

[6]. M. A. Vigeant, A. Cheville, D. M. Ebenstein, M. Lamparter, S. Shankar, N. P. Siegel, and S. Thompson, "B-Fab: Cultivating Student Learning in the Maker Space Through Faculty Development" in *Proceedings of the 2020 ASEE Virtual Annual Conference, June, 2020, Virtual On line.*

[7]. Engineering Unleashed Faculty Development Workshops, Engineering Unleashed, Accessed on: February 2023. [Online]. Available: https://learningevents.engineeringunleashed.com/pages/2023-home-page

[8]. Cards 101 How to Create Cards, Engineering Unleashed, Accessed on February 2023. [Online]. Available: https://engineeringunleashed.com/card/1705

[9]. R. B. Cialdini, (2001). *Influence: science and practice. Boston, MA: Allyn and Bacon.*

[10]. A. Bandura, (1986). *Social foundations of thought and action: A social cognitive theory.* Prentice-Hall, Inc.

[11]. A. Bandura, (2001) Social Cognitive Theory: An Agentic Perspective. Annual Review of Psychology, 52, 1-26. https://doi.org/10.1146/annurev.psych.52.1.1

[12]. G. M. Fleming, J. H. Simmons, M. Xu, S. B. Gesell, R. F. Brown, W. B. Cutrer, J. Gigante, and W. O. Cooper, 2015. *A* Facilitated Peer Mentoring Program for Junior Faculty to Promote Professional Development and Peer Networking. *Acad Med. 2015;90:819–826.*

[13]. M. K. Anderson, R. J. Anderson, L.S. Tenenbaum, E. D. Kuehn, H. K. M. Brown, S. B. Ramadorai, and D. L. Yourick, (2019). "The Benefits of a Near-peer Mentoring Experience on STEM Persistence in Education and Careers: A 2004-2015 Study." *Journal of STEM Outreach, Vol. 2.* https://doi.org/10.15695/jstem/v2i1.01

[14]. P. Varkey, A. Jatoi, A. Williams, A. Mayer, M. Ko, J. Files, J. Blair, and S. Hayes, (2012). "The positive impact of a facilitated peer", *BMC Medical Education 2012, 12:14.*

[15]. S. Chanchalani, D. Chang, J. S. L. Ong, and A. Anwar, (2018). "The value of peer mentoring for the psychosocial wellbeing of junior doctors: a randomized controlled study," *MJA 209 (9).*

[16]. P.J. Collier, (2017). Why peer mentoring is an effective approach for promoting college student success. *Metropolitan Universities Vol. 28 No. 3.*

[17]. D. K. Smith, A. D. Martinez, J. Lanigan, K. Wells-Moses, and C. Koehler, "Scholarly Mentor Program: Supporting Faculty in the Writing and Publication Process," *Journal of Faculty Development*, vol. 32, no. 1, pp. 45-50, 2018.

[18]. S. F. Young, W. A. Gentry, and P. W. Braddy, (2016). "Holding leaders accountable during the 360 feedback process," *Industrial and Organizational Psychology*, vol. 9, no. 4, pp. 811-813.

[19]. Reinhold, D., Patterson, T., and P. Hegel, Make Learning Stick Best Practices to Get the Most out of Leadership Development, *Center for Creative Leadership*, 2015.

[20]. R. B. Cialdini, "The Uses (and Abuses) of Influence," 23-Oct-2014. Accessed: December 9, 2020. [Online]. Available: https://hbr.org/2013/07/the-uses-and-abuses-of-influence.

[21]. H. M. Matusovich, M. C. Paretti, L. D. McNair, and C. Hixson, "Faculty Motivation: A Gateway to Transforming Engineering Education, *Journal of Engineering Education*, vol. 103, no. 2, pp. 302-330, April 2014.