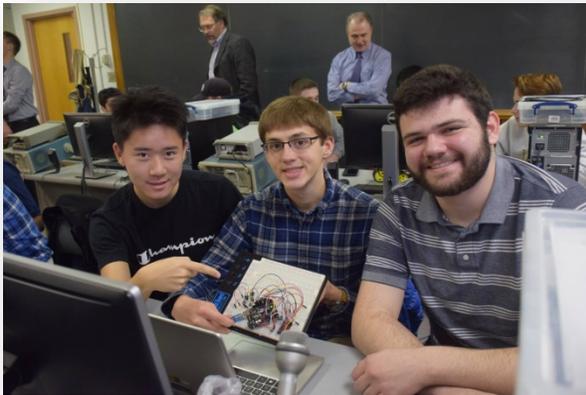


A WORK-IN-PROGRESS:  
*We ARE...DUINO!*  
*a project-based first-year experience,*  
*collaborative with the IEEE student chapter*

In this work-in-progress (WIP) paper, we will invite discussion about our recent and ongoing efforts in developing a first-year experience for Electrical Engineering (EE). A common desire of undergraduates in EE (and we suspect across engineering in general) is for more “hands-on” experiences. What little they get tends to be later in their college career; however, as the Do-It-Yourself (DIY)/Make culture continues to grow, more of our students are walking in the door ready and willing to “get their hands dirty” on day one. Couple this with an old ‘One-Room-Schoolhouse’ approach and we have the crux behind our project: Guiding established students (associated with IEEE) to assist in instruction focused on “getting hands dirty” ... EE style! The goal is to inspire a generation to work with their hands, as well as attract a subset into EE.

A hands-on first-year engineering experience seminar (FYS) has been developed here at Penn State, based around acquainting students with the usage of an Arduino microcontroller (a major building block for many a DIY project). It has been taught since Fall 2017 (Fa17). The Fa17/Sp18 classes were led by IEEE student leader Josh Cetnar. Each semester has included team project development and presentations, which has seemed to up enthusiasm levels markedly. Final Fa17 project demo day was attended by the dean, as well as department and school heads (see below). Our course continues to evolve under the new teaching intern (and co-author of this paper) Erica Venkatesulu for Fa18-Sp19, with additional freshman joining in on IEEE activities. Erica will return for Fa19-Sp20.



Much of our current teaching structure lacks concrete connections to applicable, hands-on examples [1,2,3] in spite of the commonly understood benefit of active learning [4]; this motivates our project. Initial impact will only be on 24 students per semester in the trial course. With an anticipated 5 sections in the coming years, though, over 100 students/year will be directly impacted, noting importantly that these students will be college wide (Makers know no departmental boundaries).



IEEE



Keep in mind that there will be additional student impact... the IEEE and HKN [5,6] undergraduate instructors and tutors involved in this effort will themselves be enriched for the better. As we all know, you don't *really* understand something until you have to teach it yourself. This is one of the most exciting parts of the project for us (and likely for our freshmen as well; they appear to connect well with peer instructors).

Our premise for this effort is that peer instruction [7,8] at the entry level is more effective at inspiring/motivating new students to choose an experimental engineering career path (with an obviously hopeful bias towards EE, of course). In other words, the novelty of this work isn't necessarily the hands-on aspect (though that was our original driving factor), it's the ownership of the seminar by potential peers.

Assessment is currently our primary challenge, hence this WIP paper with its implied solicitation of ideas. Some methodologies are being explored. For example, anecdotal in-class evidence has been collected over these original 4 semesters. In addition to this, we will discuss results of outreach to former students as we begin to see what long-term impact the seminar has on their subsequent college and career choices. Our hope is to expand to multiple seminars, each based on technologies useful to the DIY ethic (e.g., Raspberry Pi, Wearable Tech, etc.). Finally, we look forward to brainstorming ideas for future/further directions at the conference

Our first questionnaire/survey is shown to the right. This fillable pdf was disseminated to 4 semesters' worth of students (80+) via e-mail in late Spring 2019, with a reminder one month later. Response has been poor thus far (below the level required for proper statistical analysis). Anecdotally, some initial feedback from the questionnaires include:

- *"I still code with my Arduino from class for club projects and even some personal"* (multiple responses)
- *"I now go to IEEE workshops"* (multiple responses)
- All surveys received so far give highest marks to the undergraduate instructor!

*Some Questions about  
We Are ... DUINO  
EE 009: First-Year Experience*

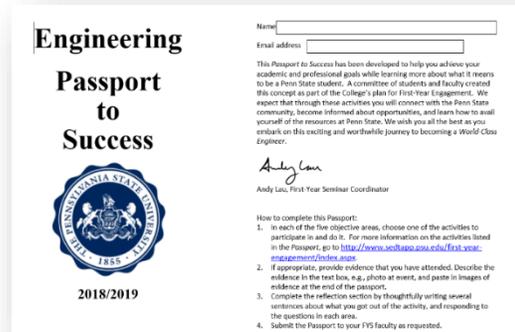
- 1) Based on your friends and colleagues, what were your expectations for a first-year seminar course?
- 2) How did your first-year seminar experience compare to these expectations?
- 3) Please rate how the following elements of EE 009 helped you be successful in later courses:
  - a. Breadboarding
  - b. Writing code
- 4) Did your experience inspire you to participate in IEEE or an equivalent student organization? Tell us about your experiences/activities.
- 5) What impact has EE 009 had on your Penn State experience?
- 6) What were the strengths and areas for improvement of the undergrad instructor in EE 009?
- 7) When did you take EE 009?
- 8) Did your experience in this course help or inspire you to participate in undergraduate research? If so, please tell us about your experience.
- 9) What is your current or intended major?
- 10) Have you built any electronic projects since this class?
- 11) Did you make any friends in your EE 009 class that you are still friends with?

**Submit Form**

In addition to surveys, anecdotal successes have also included (using students' first names only):

- Rahul and Rebecka (1<sup>st</sup> semester offered) both joined the IEEE student chapter in active roles as Freshmen and have quickly risen to chair and officer positions.
- Harrison (3<sup>rd</sup> semester offered) is also active in the IEEE student chapter.
- Tommi (3<sup>rd</sup> semester offered) is already tied-into undergrad EE research, as well as helping with APOGEE (a summer camp spun-off from this FYS; see below)
- Abby (4<sup>th</sup> semester offered) is an honors student; she switched majors into EE based on this experience.

Note that our FYS, like most College of Engineering FYS here at Penn State [9], utilizes the Passport for Success (see to the right). This program expands new students' experiences campus wide. Its influence on student perception of the course will have to be teased out of any additional data we collect regarding efficacy of peer instruction as well as tangible, hands-on experimentation, however.



Finally, as mentioned above, aspects of this course are inspiring aspects of the APOGEE camp (*Anything is Possible for Girls in Electrical Engineering*; offered summers 2018 and 2019 thus far) [10]. Peer instructed, hands-on experimentation is also proving inspirational at middle-school aged-levels. Starting there, through the FYS, and beyond, we want the students to keep Making [11].

## References

- [1] Carlson, Lawrence E., and Sullivan, Jacqueline F., "Hands-on Engineering: Learning by Doing in the Integrated Teaching and Learning Program," *Int. J. Engr. Ed.*, Vol. 12, No. 1, pp. 20–31, 1999.
- [2] Edwards, David, "American Schools Are Training Kids for a World That Doesn't Exist," *Wired*, 17 October 2010, available at <http://www.wired.com/2014/10/on-learning-by-doing/>.
- [3] *Educating the Engineer of 2020 – Adapting Engineering Education to the New Century*, by the Committee on the Engineer of 2020, Phase II, Committee on Engineering Education, National Academy of Engineering, 2005.
- [4] Prince M. (2004). "Does Active Learning Work? A Review of the Research." *Journal of Engineering Education.*, 93(3), 223–231. <https://doi.org/10.1002/j.2168-9830.2004.tb00809.x>
- [5] Penn State's IEEE Student Branch at University Park <http://sites.psu.edu/psuieee/> (accessed July 2019).
- [6] Eta Kappa Nu (HKN) – Epsilon Chapter <http://sites.psu.edu/hkneecs/> (accessed July 2019).
- [7] Ramaswamy, S., Harris, I., Tschirner, "Student Peer Teaching: An Innovative Approach to Instruction in Science and Engineering Education," *U. Journal of Science Ed. and Tech.* (2001) <https://doi.org/10.1023/A:1009421231056>
- [8] Boud, David, Ruth Cohen, Sampson, Jane, *Peer Learning in Higher Education: Learning from and with Each Other*, First Published 2001, eBook Published 2014, Routledge <https://doi.org/10.4324/9781315042565>
- [9] First Year Seminars (FYS) <http://www.sectapp.psu.edu/first-year-engagement/index.aspx> (July 2019).
- [10] APOGEE Summer Camp <https://sites.psu.edu/apogee/> (accessed July 2019).
- [11] Make Magazine <http://makezine.com/> (accessed July 2019).