



## **Work in Progress: Co-curricular and Extra-curricular Experiences of NSF-supported Scholars**

### **Prof. Huihui Wang, Jacksonville University**

Dr. Huihui Wang, is an assistant professor and the Chair of the Engineering Department at Jacksonville University (JU). She is an advisor of the National Society of Professional Engineering (NSPE) at JU. She is the senior member of IEEE and the Vice Chair of IEEE Jacksonville Section. She is also the member of ASEE and ASME and FES. She has served as a technical program committee member and a reviewer for international conferences, journals as well as fellowships.

### **Dr. Lee Ann Jerome Clements, Jacksonville University**

Dr. Lee Ann J. Clements is the Associate Provost for Accreditation at Jacksonville University. Prior to serving in this role she served for twelve years as the Chair the Division of Science and Mathematics. She received her B.A. in Biology from the University of Virginia, her M.S. and PhD from the University of South Carolina in Marine Science. Her research projects have included investigating the role of metallic pollutants in altering development, the effects of environmental variability on skeletal regeneration, and the effects of ocean acidification on marine organisms. She is also involved in projects that help communicate science to the general public and is one of the creators of The Science Of . . . a web-based video magazine. In addition to her role as Associate Provost Dr. Clements is also the director of Experiential Learning and a tenured Professor of Biology and Marine Science at Jacksonville University.

**Cindy Leong**

**Misha M Chalkley**

**Mr. Crandall Maines, Jacksonville University Engineering**

# Co-curricular and Extra-curricular Experiences of NSF-supported Scholars

## Abstract

The Mathematics, Engineering, and Physics (MEP) scholar program at our university supported by NSF S-STEM scholarship program is preparing individuals for the STEM workforce by providing an educational experience that emphasizes student discovery. Scholars are selected annually based on academic ability and financial need. Faculty mentoring, tutoring, peer study groups, college survival skills training, career development, and undergraduate research experiences are all tools to help the scholars. Some MEP Scholars are actively participating in the following research projects: 1) Design and Development of an e-Health System, 2) Design and Development of an Electronic Health Records program, 3) Study of the Field Effect on Charge Transport through Conductive Polymers Injected in Vascular Channels of Angiosperm Leaves, and 4) A 3D-printed desk organizer. In this paper, MEP Scholars briefly present their projects and share their thoughts and reflections about the MEP scholar program. These activities have helped to build up and strengthen close connections between scholars and faculty. The connections have translated into an improved retention rate and enhancing recruitment of new students to STEM programs.

## Keywords

Co-curricular, Extra-curricular, Undergraduate research, NSF S-STEM MEP.

## 1. Introduction

We are a small predominantly undergraduate institution (PUI) and liberal arts (LIA) private university. We received this NSF award in July 2014. The award has three goals:

1. Improve the enrollment of students in engineering-related degrees;
2. Improve enrollment of underrepresented groups in engineering-related disciplines;
3. Improve retention through graduation or transfer to an affiliated institution in engineering-related disciplines.

So far, we have recruited 23 students in this MEP Scholarship program, and 16 of 23 students are awarded scholarships. Two scholars have transferred to other institutions because they were in our 3+2 engineering dual degree program. Other results about the enrollment, retention rate and graduation rate are listed in Table 1.

Table 1 Comparison of program targets vs actual results

Objectives	Target by June 2019	2014-2017
Enrollment increase in engineering related fields	40	33
The number of women in engineering related fields	36	32
The number of underrepresented minorities in engineering related fields	40	53

Retention rate among the MEP scholars	88%	2014-2015: 80% 2015-2016: 72% 2016-2017: 100%
Graduation or transfer rate among the MEP scholars	81%	Graduation of cohort expected 2018

The enrollment growth is 9% in the targeted STEM fields represented in this grant, and 7% for all STEM majors (including biology, chemistry and marine science). Overall undergraduate enrollment growth at the university was 4.5% from fall 2015 to fall 2016. Both STEM and the targeted majors for this project exceeded the overall undergraduate growth at the university by 2.5 to 4.5%.

The project has succeeded in meeting the goals for underrepresented minorities enrolled in engineering related fields, and retention rate of students. The retention rate of students in MEP scholarship program is higher than the retention of engineering majors at our institution (students not in the program ~75%). One reason is the faculty support structure. Both overall enrollment and number of women in engineering fields are within reach of the goal by the end of the project. The success of the program can be attributed to MEP scholarship program activities and adjustments we have made since we received the grant. In spring 2015, we extended our scholarships to the students in the computer science major. This expanded the pool of students eligible for the program. In fall 2015, our 3+2 engineering dual degree program transitioned to 4-year B.S. degrees in mechanical engineering and electrical engineering. The change to four-year programs reflected prospective student demands and resulted in increased applications to the university and likewise an increased pool of applicants for the MEP scholarship program.

Each year activities are scheduled to promote a sense of academic community, allow mentoring towards academic and career goals, and provide enrichment opportunities. Academic community is built through orientation activities, mask building, t-shirt design and movie and game nights. Mentoring occurs in these settings, but also through program elements including workshops with the Career Resource Center and Academic Support Center, and field trips to local engineering firms and businesses with a technology focus. Finally, enrichment opportunities include guest speakers, undergraduate research projects, Mathematical Contest in Modeling and field trips. Because of the frequent interactions with professors, MEP scholars have chances to collaborate with professors across the fields to work on undergraduate research projects. Through this type of co-curricular activity they have hands-on project experiences and chances to reflect on their projects and the impacts of this MEP scholarship program on them.

In this paper, we focus on introducing four MEP scholars' experiences with undergraduate research projects. Interdisciplinary undergraduate research activity efficiently improves students' learning, and increases retention rate and graduation rate [1-8]. The projects described below along with excerpts of short interviews with the student researchers, the variety of projects and the value students place on MEP scholarship experiences.

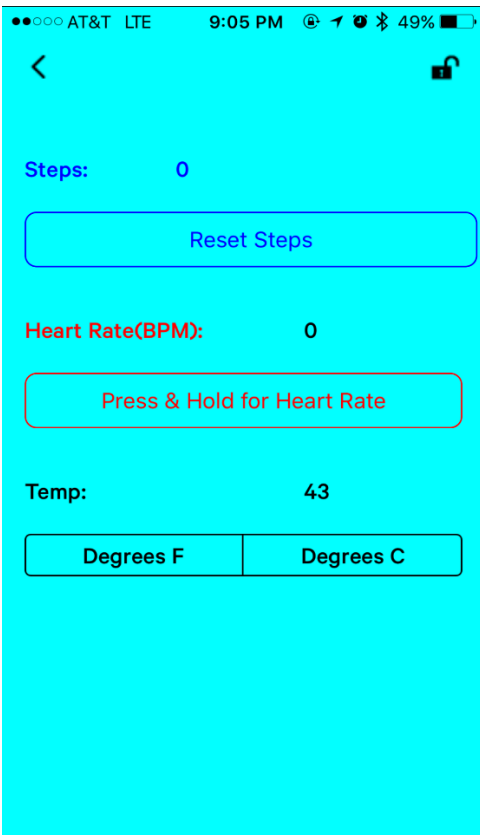
## 2. Undergraduate Research Projects

In this section, four MEP scholars share the undergraduate research projects. Some projects were done by MEP scholars only (such as project 2 and 4) and others were done by a team which included one MEP scholar. The projects illustrate the variety of ideas generated on campus and span interests from healthcare to basic biology and design of a home/office-use device.

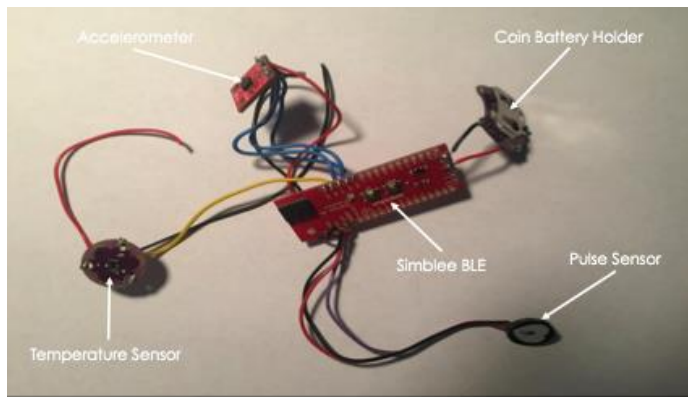
1) Design and Development of a Self-Monitoring Health System

A portable and cost-effective self-monitoring health system was designed and developed. The goal was to create a system that measures health through sensors and then wirelessly transmits the data to be read and stored.

This system utilizes a Sparkfun Simblee BLE board, a LilyPad temperature sensor, a Sparkfun triple axis accelerometer, a pulse sensor, and a 3V coin cell battery and holder. The system is connected via Bluetooth to a phone and displays steps taken, the heart pulse through the wrist, and ambient temperature in an App. The App display is user friendly, allowing the user to reset parameters. The housing was chosen to be an iPod nano 7th generation case with Velcro attached to keep the holder positioned on the wrist. Figure 1 illustrates the system setup including the App display and the hardware setup. This project is supported by our internal grant.



(a) Phone Application Display



(b) The Self-Monitoring Health System Hardware Setup



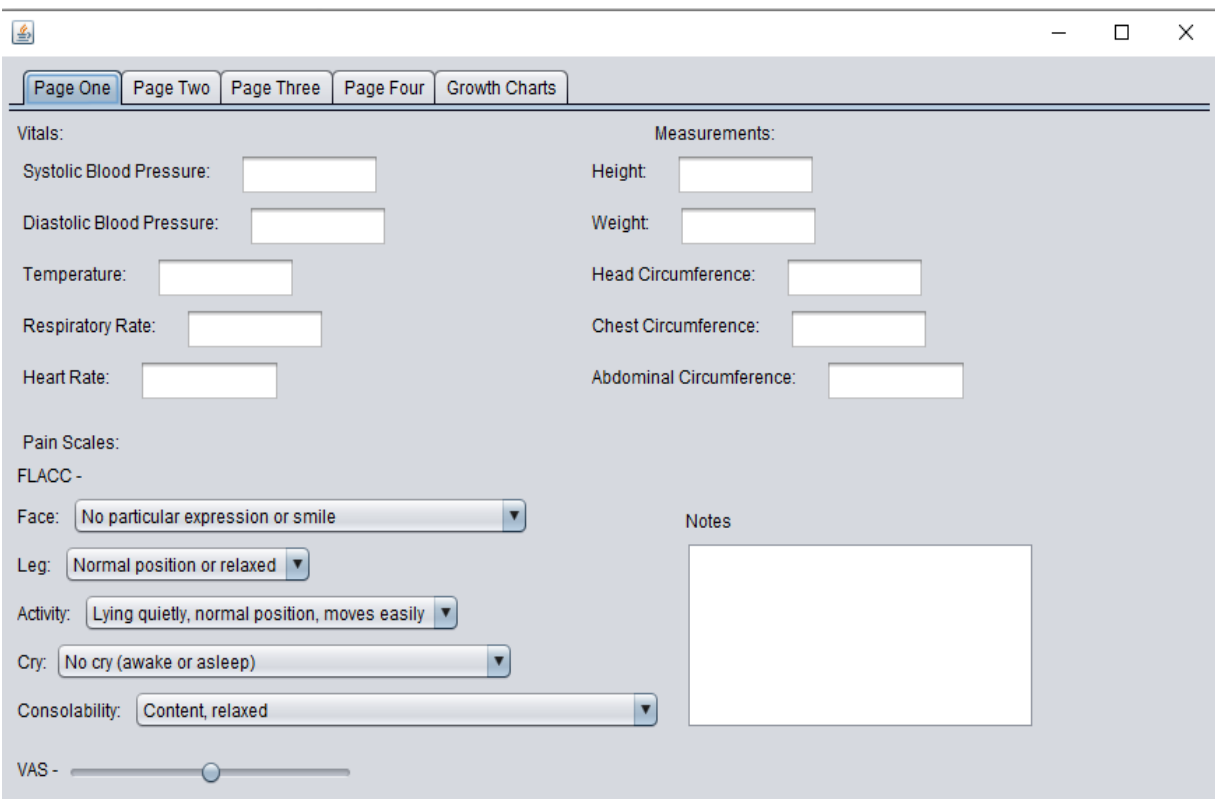
(c) The Self-Monitoring Health System Housing

Figure 1 A self-monitoring health system

2) Design and Development of an Electronic Health Records program

Students in the Department of Computer Science in collaboration with the Kegwin School of Nursing at JU created a replica of the Electronic Health Records program. We used JAVA for creating the user interface, and SQL for the back end. Each assessment talks to the “General Form”. The “General Form” provides the patient ID, patient name, and patient date of birth that are displayed in the pages necessary. The students can enter input using textboxes in the Electronic Health Records. The program also has view assessments options for students to look at previous records for specific “patients”. The Electronic Health Records program also prompts a message box if the nursing student did not enter a necessary field.

The hardest part is trying to manage the program at such a large scale without it falling apart. Now we are at our final stage of the program, finishing up the Pediatrics and Obstetrics assessments. The project will tentatively complete by the end of all 2017. We are also working with the nursing department to get a server space to store a database in order for all of the computers to have access to a single database instead of having the data stored locally. Figure 2 illustrates an example of electronic health record form.

The image shows a screenshot of a web-based electronic health record (EHR) form. At the top, there are five tabs: "Page One", "Page Two", "Page Three", "Page Four", and "Growth Charts". The "Page One" tab is currently selected. The form is divided into several sections. On the left, under "Vitals:", there are five text input fields for "Systolic Blood Pressure:", "Diastolic Blood Pressure:", "Temperature:", "Respiratory Rate:", and "Heart Rate:". On the right, under "Measurements:", there are five text input fields for "Height:", "Weight:", "Head Circumference:", "Chest Circumference:", and "Abdominal Circumference:". Below these, under "Pain Scales:", there is a section for "FLACC -" with five dropdown menus for "Face:", "Leg:", "Activity:", "Cry:", and "Consolability:". At the bottom left, there is a "VAS -" section with a horizontal slider. On the right side, there is a "Notes" section with a large text area for entering notes.

**Figure 2 An example of electronic health record forms**

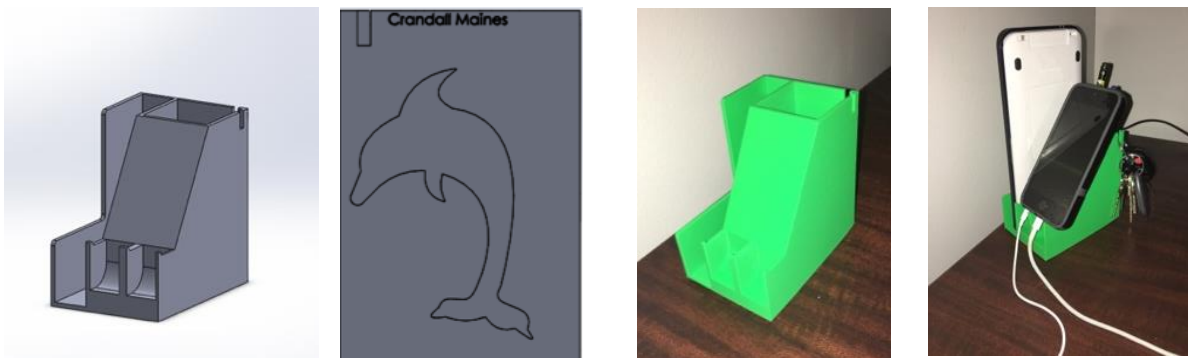
3) Study of the Field Effect on Charge Transport through Conductive Polymers Injected in Vascular Channels of Angiosperm Leaves.

Plants use their vascular system of xylem and phloem to transport nutrients to and from the leaves, respectively. When xylem in the stem of a rose plant was exposed to conductive polymer

solution, the polymer itself can be transported along the xylem. This creates a set of conductive channels that run through the stem of the plant which is capable of transporting electrical current. By taking advantage of the geometry, the stem can act as a transistor and also a super-capacitor. Like the stems, leaves of the plants also possess a vascular network. In case of angiosperms, the vascular network consists of channels running almost parallel to each other. In this project, we will be using such leaves from an angiosperm and inject conducting polymers through the laminar network of the vascular system. We will study the charge transport properties through a section of such leaves and study the effect of the external electric field on the transport. Observation of the field effect on the charge transport through these leaves would pave a way for us to construct flexible transistors almost entirely based on a plant product. We will then study the electronic properties of this plant based transistor to understand whether the transistor will be suitable for application as a sustainable alternative to organic field effect transistors. This project is supported by our internal grant. Two professors from the Department of Engineering (one Co-PI of this grant) and the Department of Physics are collaboratively supervising this project.

#### 4) A 3D-printed desk organizer

In the course project of “Computer Aided Design”, I created a desk organizer prototype that would make the life of the user more efficient. A prototype must first be created in a computer aided design software Solidworks, if one wishes to use a 3D printer to realize any design idea. A useful desk organizer was designed within the following criteria: less than 4”x4”x4” cube, at least five features, and three of five features should have unique functions. In order to create a well-crafted final prototype, the designer must fully understand the limitations of the 3D printer in use. Having taking all of these factors into account, my final prototype included a phone recliner, charging doc, key holder, pencil holder, TI-Nspire storage and dolphin emblem illustrated in Figure 3. The Solidworks software and the 3D printer can be accessed by any student in the engineering department.



(a) Model files in Solidworks

(b) The 3D printed Prototype

**Figure 3 The 3D printed desk organizer**

### **3. MEP scholars’ reflections about the MEP program**

This is our very first round interview. Based on the ethnography-based interview method, we tried to hear students’ own words rather than guiding them with directions. We started with four MEP scholars first to get some preliminary results which will guide our follow-up interviews and

surveys. Four MEP scholars were interviewed in order to know what their reflections about impacts of the MEP scholarship program on them. During the video recorded interviews at our TV station, six questions were asked related with comments and reflections of undergraduate research experiences. Due to the page limit, we here excerpt parts of our interviews. Prior to beginning this project, our data collection procedure was approved by our Institutional Research Board (IRB: 2016-042). Each participant signed an IRB-approved consent form agreeing to allow us to present the results, provided participants remained anonymous. Their major and grade year information is listed in Table 2.

**Table 2 Demographic Information of Interviewees**

Student	Grade	Gender	Major
A	Senior	Female	Electrical engineering major
B	Senior	Female	Computer science and math majors
C	Senior	Female	Physics major
D	Sophomore	Male	Mechanical engineering major

Question 1: Give me a sense of what it is like to be a MEP scholar.

Student B: “Being in MEP scholarship program enabled me to interact closely with not only professors in my field of studies, but also professors and students across STEM discipline. I would not have known any Engineering or Physics professors and students if I did not join the MEP scholarship program. The program also enables me to stand out among my peers. I am fortunate to be one of the first people whom professors think of when they need students to join their research projects.”

Question 2: What are some things you can say about yourself that have changed as a result of participating in MEP Scholarship program?

Student D: “The MEP scholarship program has given me confidence that my chosen field of study (mechanical engineering) is the right one for me. The extracurricular activities have given me an in-depth look into what my future may hold.”

Question 3: What are some kinds of things you can do as a physics student that you might not have been able to do if you did not join the MEP scholarship program?

Student C: “If I were not in the MEP scholarship program I probably would not be as involved with interdisciplinary projects. For example, I am doing departmental honors research for Physics, but the project is a joint effort of the Physics and Engineering departments. If I was not in the MEP scholarship program, it would have been very tempting to have a pure physics project and do it on my own rather than in a group, and this is mainly because I would have lacked exposure to the other STEM fields and not see the connections as well as I do through the MEP scholarship program.”

Question 4: Describe any co-curricular and extracurricular activities as the MEP scholar you have participated in, and their impact on your professional identities and career readiness.

Student A: “The MEP scholarship program has allowed me to participate in many extracurricular activities! They have offered not only school/educational opportunities, but also social opportunities to help everyone in the program get to know each other better. I have had the opportunity to tour multiple companies that offer jobs in the engineering fields. Furthermore, the

MEP scholarship program has allowed me to meet with the employees of various companies and enhance my speaking skills. The MEP scholarship program also offer activities to prepare you for your time after JU such as a resume readiness workshop.”

#### **4. Summary and future work**

We focus on exploring four MEP scholars’ reflections on their co-curricular and extra-curricular activities during the past three years in this paper. They have been actively involved in this program and benefited from frequent interactions with faculty mentors. Most of them started working on undergraduate research projects early in their college career because of the frequent interactions with faculty. They feel they are special because of the many opportunities to participate in extra-curricular activities. They have matured intellectually and professionally, built their confidence, and strengthened their understanding about their majors and careers through those activities. Early connection with faculty and engaging activities further strengthen the bond students have with their chosen major. This translates into higher retention compared to students not involved with the research projects, field trips and activities. Furthermore, engaging students early in research projects and activities, and advertising early engagement and opportunities are good recruitment tools for future students.

In the near future, we will expand this undergraduate research practice to all other MEP scholars by sharing positive feedback from these four scholars and helping them connecting with other professors whose research interests may be matching with scholars’. We will then interview them and other non-scholars but engineering students to compare results. We wish our results and findings will be useful for other small engineering departments at similar PUI LIA institutions.



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