An Integrated Social Justice Engineering Curriculum at Loyola University Chicago

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Introduction

In planning to start engineering at Loyola University Chicago (LUC), the new Director decided to integrate social justice with engineering in the curriculum. This decision seemed a natural extension of Jesuit universities’ emphasis on social justice. LUC’s BS Engineering Science program began the following year in August, 2015.

Background

In his 1968 survey for ASEE, *Liberal Learning for the Engineer*, Sterling Olmsted counted 93 engineering schools that had initiated programs in liberal studies in the last three years. By 1973, as a result of this report, almost 200 technical colleges experimented with curricula to address the social implications of technology. Two curricular approaches included “humanizing” engineering through interdisciplinary education and creating social-scientific experts outside of engineering [1].

Upon this foundation, the challenge of adding social justice to the engineering curriculum began to be discussed. In 2008, the National Science Foundation sponsored a workshop on Social Justice, Sustainable Community Development and Engineering at the National Academy of Engineering, which included a session titled “Implications for Engineering Education” [2]. In reflecting on the workshop, lead workshop organizer, Rachelle Hollander, noted that “the question of engineering and social justice was a hotly contested topic at the meeting, while humanitarianism and engineering or engineering and social responsibility was not. Some engineers did not think social justice (whatever it was) was an appropriate issue for engineering practice or for consideration in their societies; others disagreed [3, 4].” While later discussing curricular initiatives, Dean Nieusma stated that “Notably absent…are efforts to systematically integrate social justice content across “core” engineering science courses in a given curriculum. While members of ESJP [Engineering, Social Justice, and Peace] have paved new paths within individual core courses, what curricular experimentation there is exists at the margins of engineering curricula (i.e. the non-core courses: design, professional development, H&SS [Humanities & Social Sciences] content) [5].” Annual ESJP conferences, “committed to envisioning and practicing engineering in ways that extend social justice and peace in the world,” had been held since 2004 [6]. More recently, in their textbook, *Engineering Justice*, Leydens and Lucena cited student attitude and faculty attitude as challenges to integrating social justice into engineering science courses [7].

Efforts to integrate social justice into engineering science courses include course modules developed by Catalano, et al. on peace, poverty, and sustainability [8, 9]. In addition to coauthoring these modules, Donna Riley created a thermodynamics course that included twenty modules based on pedagogies of liberation [10]. Later, Johnson, et al. integrated social justice concepts into an introductory control systems course. During the second semester the course was
given, they focused on active prosthetic control and wind turbine control applications [11]. In August, 2015, the Shiley-Marcos School of Engineering at the University of San Diego (USD) was awarded a $2 million grant by the National Science Foundation to revolutionize engineering education by creating changemaking engineers. According to a 2018 description of USD courses in the new Integrated Engineering program, user-centered design, engineering and social justice, and engineering peace courses have been implemented that incorporate “social justice thinking” and “analyze how engineering knowledge is constructed and used to perpetuate inequities [12].”

LUC’s Director was unaware of these issues and implementations when she began planning her program in October, 2014. Per Board of Trustee approval, the BS Engineering Science program would have three specializations: biomedical, computer, and environmental engineering. Per the Director of the University Core Curriculum, the curriculum would include twelve liberal arts courses (36 semester cr hr). But other program aspects were undefined. As an engineering graduate of a sister Jesuit University and an engineering ethics textbook author, she believed that the combination of engineering and social justice was an obvious foundation for a program. Jesuit universities have emphasized social justice since the Jesuits’ General Congregation 32 in 1975, when “the promotion of justice” was declared central to the Society of Jesus’ mission [13, 14]. LUC demonstrated its commitment to social justice when it published its strategic plan for 2015-2020 three months before the inaugural class of Engineering Science freshmen entered in August, 2015. Titled Plan 2020: Building a more just, humane, and sustainable world, this strategic plan described eight strategies, within four institutional priorities, that are all grounded in social justice [15].

The Need For Social Justice

At LUC, we introduce our engineering students to the concept of social justice by exposing them to the work of Adams and Bell [16, 17], who see social justice as both a goal and a process. “The goal of social justice is full and equitable participation of people from all social identity groups in a society that is mutually shaped to meet their needs. The process for attaining the goal of social justice should also be democratic and participatory, respectful of human diversity and group differences, and inclusive and affirming of human agency and capacity for working collaboratively with others to create change [18].” This one hour introduction occurs during the second course meeting of the fall freshman engineering course, ENGR 101, and includes an overview of issues for which Jesuits advocate [19] and a discussion of how microaggressions will not be tolerated in Engineering Science [20], which we refer to as social justice in the classroom.

It is important that our students understand that engineering products affect public safety. Often, when engineering decisions are impaired, the marginalized are the most affected. For example, in 2013, eight years after Hurricane Katrina flooded 80% of New Orleans when the levees breached [21], poorer neighborhoods had been much slower to rebuild than more affluent areas. Some residents had sold their properties to the state and others who wanted to rebuild had not received sufficient federal funds to cover costs [22, 23].

Before the 2010s, engineers often provided warnings of potentially dangerous situations to their superiors, even though the warnings were ignored. In fact, the Director hypothesized that by investigating twelve engineering disasters, from the San Francisco-Oakland Bay Bridge
Earthquake in 1989 to the second Space Shuttle Explosion in 2003, she would find an engineer who warned of each dangerous situation. Her textbook, *Engineering Ethics: An Industrial Perspective*, provided case studies of these disasters and included the engineers or engineering technicians who delivered warnings [24].

The Director declined Elsevier’s offer to publish a second edition of *Engineering Ethics*, and instead investigates more recent engineering disasters as the basis of new social justice case studies for her students. Through these investigations, she has observed the switch from engineers warning of dangerous situations to fully participating in these situations. As our culture has changed, engineers are now participating in fraud with greater frequency. For example, Oliver Schmidt, former manager of Volkswagen’s Engineering and Environmental Office in Michigan, is currently serving seven years in federal prison for conspiring to defraud the federal government and for violating the Clean Air Act [25]. While engineering ethicists might argue that we must strengthen our engineering society codes of conduct [2], this is not a practical solution, as these codes are not emphasized on the job. We believe we should prepare our students for industry by first exposing them to social justice issues and then analyzing the engineering environments that await them. Then if a request to falsify data occurs, they have a plan of action.

Interestingly, students who persist in engineering also value social justice. In the NSF-funded Academic Pathways for People Learning Engineering Survey (APPLES), social good received the highest average score of four motivations from 753 millennial students at four institutions who persisted in engineering over five years [26]. In predicting the engineering career intentions of 6,722 students from 50 institutions enrolled in the NSF-funded Sustainability and Gender in Engineering (SaGE) survey, Klotz, et al. determined students were more likely to choose engineering if they wished to address energy-related issues, water-supply issues, or opportunities for future generations their careers [27]. Since students enrolling at LUC are drawn to our sustainability initiatives [28, 29] and Deferred Action for Childhood Arrivals (DACA) efforts [30-32], an integrated social justice curriculum is a good match for our student population.

**We hypothesize that engineering persistence can be increased by emphasizing social justice. Increased persistence to graduation is the main goal of our BS Engineering Science program.**

Social Justice Initiatives

We believe in social justice for our students and faculty. Social justice initiatives in the Engineering Science program include the following:

1. Specializations with social justice applications – In our curriculum, students take common courses over five semesters, and then specialize in either biomedical (BME), computer (CompE), or environmental (EnvE) engineering. In the BME specialization, our students learn to design and test robust medical device software, in preparation for a medical device to be cleared or approved by the Food and Drug Administration. We believe all patients should receive high-quality medical devices, regardless of their ability to pay. All BME courses are patient-centered, which is atypical of medical device and medical device regulation courses. For example, when the Director teaches eighteen electrical and mechanical medical devices
that have saved numerous lives in her Medical Device Systems course, five requirements from applicable engineering standards are discussed for each medical device. As a former Vice President of Research in the medical device industry, she asks students to reflect if each requirement is more geared towards the manufacturer (i.e. vague, relatively easy to meet) or the patient (i.e. requires rigorous testing, ensures patient safety).

In the CompE specialization, our students learn how to design programmable systems for the smart grid, which could relieve our dependence on nonrenewable coal, oil, and gas and could combat climate change. In the EnvE specialization, our students learn engineering design and analysis for the water/wastewater treatment industries. Although environmental regulations constrain design choice, students are exposed to best management practices that prioritize green rather than grey infrastructure. A focus on appropriate technology solutions further requires our students to considering the context of their designs to ensure long term sustainability for the target community [33].

2. Active learning curriculum – All engineering courses are taught using a mandatory minimal lecture style. Emulating the teaching at the U.S. Air Force Academy [34-36], the first ten to fifteen minutes of a 50 minute course meeting are a mini-lecture to go over fine points of the homework. The remaining course time is devoted collaborative learning or problem-based learning group activities, which may span that course meeting, an entire semester, or several semesters. Each course section holds no more than 24 students, to facilitate instructor check-in and feedback during the activity to increase learning [37]. Active learning has been demonstrated to retain female students, students of color, low-income students, and first-generation college students [38-41].

We are implementing two multi-semester projects, which we call curricular contextual threads, on patient monitoring and sustainable buildings. The first curricular contextual thread, which enables each student to build a functional cardiograph over four semesters (Figure 1), is being evaluated for its effect on student engagement and engineering persistence.

![Figure 1. LUC Patient Monitoring Curricular Contextual Thread: Cardiograph Project](image)

The sustainable buildings curricular contextual thread will begin to be evaluated in 2019.

Specifically, since Fall 2017, students complete the Assessing Women and Men in Engineering (AWE) Annual survey [42, 43] (NSF HRD #0120642, [http://aweonline.org/](http://aweonline.org/)) at the beginning of freshman year and annually thereafter. Students also complete pre-and post-assessments, which include the Student Response to Instructional Practices (StRIP) Instrument [44], when they conduct each part of the cardiograph project. Student assessments from Part II of the cardiograph project provide evidence for the evaluation of ABET Student Outcome (1): An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. For each Student Outcome, we
determine if 80% of students have reached the two highest levels (out of four total levels) of several performance indicators.

3. Social Justice Case study days – We are in the process of embedding five social justice case study days in five semesters of the curriculum, with one new case study day debuting each year. Four case study days are currently embedded in: ENGR 101 Introduction to Engineering Design, ENGR 201 Experiential Engineering, ENGR 321 Electrical Circuits and Devices, ENGR 391/392/393 BME/CompE/EnvE Capstone Design II. Through these case studies, students analyze the impacts of various technologies on society and consider how their future work will affect others. The case study format varies each semester. Engineering case studies sensitize students to experiences outside of the classroom [45-47], and increase critical thinking and engagement [48, 49].

Through the joint case study, which is implemented in ENGR 321, groups of two to three sophomores investigate various aspects of a case, which has technical and other elements. The joint case study grade is worth 10% of the final grade for ENGR 321. Each student writes a 700 word essay about the assigned topic and a 300 word essay about how the sophomore class can realistically contribute to solving the problem. Both essays require citations: at least five citations for the 700 word essay and at least one citation for the 300 word essay. Each group gives a five minute presentation, and then the entire class discusses the problem. When the joint case study debuted in Spring, 2018, class of 2020 sophomores investigated these elements of Hurricane Maria: how individuals have coped, political representation, electrical infrastructure, island finances, effect of climate change on hurricanes, and response of Puerto Rican institutions.

The rubric for the joint case study is given in Table 1. Student assessments from the joint case study provide evidence for the evaluation of ABET Student Outcome (3): An ability to communicate effectively with a range of audiences. For each Student Outcome, we determine if 80% of students have reached the two highest levels (out of four total levels) of several performance indicators.

4. Faculty hiring practices – LUC screens all faculty applicants for an understanding of and commitment to social justice. Faculty search committee members rank applicants on a number of variables including “Evidence of Commitment to Diversity and Social Justice.” To further embrace social justice, the Director changed Engineering Science faculty policies. The standard LUC non-tenure-track (NTT) title was changed from “lecturer” to “clinical professor” to be more inclusive, and tenure-track (TT) and NTT faculty receive equal salaries. NTT faculty members are on three-year renewable contracts, and teach seven courses per year. They must have four years of full-time industry experience, which fulfills the ASME Vision 2030 study recommendations of hiring more faculty “with significant industry experience” and providing “faculty development opportunities for exposure to current industry practice” [50]. The majority of engineering faculty do not have industry experience [51, 52]. TT faculty members conduct research, and teach four courses per year. NTT faculty members manage the specialization curricula directions; TT faculty members manage the specialization research directions. All engineering faculty members have a Ph.D.

5. Faculty diversity – In addition to diversity of industrial experience, faculty diversity should
<table>
<thead>
<tr>
<th>Performance Indicator</th>
<th>Exemplary</th>
<th>Satisfactory</th>
<th>Developing</th>
<th>Emerging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Essay Response 1 (700 words of opinion, 5 pts)</td>
<td>Central idea is well-developed, and is accompanied by substantial evidence and critical analysis. 15</td>
<td>Central idea is generally present, and is accompanied by some evidence and critical analysis. 6</td>
<td>Central idea is vague, and is accompanied by some evidence and critical analysis. 1</td>
<td>Central idea is not present; very little evidence and critical analysis exist.</td>
</tr>
<tr>
<td>Individual Essay Response 2 (300 words of opinion, 2 pts)</td>
<td>Central idea is well-developed, and is accompanied by substantial evidence and critical analysis. 16</td>
<td>Central idea is generally present, and is accompanied by some evidence and critical analysis. 4</td>
<td>Central idea is vague, and is accompanied by some evidence and critical analysis. 1</td>
<td>Central idea is not present; very little evidence and critical analysis exist.</td>
</tr>
<tr>
<td>Quality of Resources For Citations (1 pt)</td>
<td>All citations, including websites, are credible. 21</td>
<td>One citation may not be credible. 1</td>
<td>More than one citation may not be credible.</td>
<td>Wikipedia or google.com is included in the citation list.</td>
</tr>
<tr>
<td>IEEE Citation Elements (1 pt)</td>
<td>All parts of the citation (author, title, publisher, etc.) are correctly formatted. 21</td>
<td>N/A</td>
<td>N/A</td>
<td>Inconsistent citation format.</td>
</tr>
<tr>
<td>Final Presentation Oral Skills (1 pt)</td>
<td>Speaker exhibits clear and appropriate syntax, diction, tone, and body language. 20</td>
<td>Speaker exhibits only minor problems in clear and appropriate syntax, diction, tone, and body language.</td>
<td>Speaker exhibits one major problem in clear and appropriate syntax, diction, tone, and body language.</td>
<td>Speaker exhibits more than one major problem in clear and appropriate syntax, diction, tone, and body language. 2</td>
</tr>
</tbody>
</table>

Table 1. Social Justice Joint Case Study Rubric and Spring 2018 Results (n=22).
include persons of color and both genders. During Engineering Science faculty search committee discussions, most candidates are chosen by the entire search committee for phone interviews. However, any committee member may choose to move a candidate forward for a phone interview. Beginning with the fifth faculty search, the Director intentionally advertised faculty positions more inclusively through ads on the National Society of Black Engineers and Society of Hispanic Professional Engineers websites. Faculty diversity encourages student diversity [53, 54].

The Impact of Social Justice Initiatives

Active Learning Curriculum

Engineering Science’s inaugural class, the class of 2019, started in Fall, 2015. Twenty students (37% response rate) from classes of 2020 and 2021 that remained in the program during their sophomore and junior years completed AWE surveys. One question asked students to indicate why they initially enrolled in the Engineering program, and students chose from several options. The most common responses were that they liked to solve problems (n = 18) and were good at math and science (n = 17). Nine students also indicated that they wanted to address social problems. These responses were disproportionately from students that reported identifying with an ethnic/racial minority group. There were no differences based on gender. Among the ten (40% response rate) students that completed the survey after withdrawing from the program, the most common responses had a similar pattern as the students that remained in the program, although only one student indicated that they wanted to address social problems. In other words, when faculty are able to tap students’ interests in addressing social problems, which the social justice cases aim to do, it may support student retention in engineering programs, particularly for students of ethnic/racial minority groups.

In Part II of the cardiograph project, sophomores in fall semester program a Texas Instruments microcontroller in C to acquire an electrocardiogram (ECG) signal and generate a clear and recognizable ECG profile. Briefly, during Fall, 2018, 22 sophomores, in 11 student groups, were able to successfully perform the requested tasks with high levels of engagement, as measured by the StRIP instrument. For the performance indicators LED Programming, ECG Signal Acquisition, Graphics, and Cardiograph Project Presentation Materials, the following student percentages reached Exemplary and Satisfactory levels: 100%, 100%, 100%, 45%, respectively. Thus, students reached Engineering Science Student Outcome thresholds in three of four performance indicators. Evaluation of Part II of the cardiograph project is discussed in much greater detail in [55].

Social Justice Case Study Days

The class of 2020’s presentations and discussion of Hurricane Maria were very emotional. The first group presented their observations on how individuals coped. This group consisted of two students, including Marina, whose Puerto Rican grandparents, aunts, uncles, and cousins experienced Hurricane Maria and still live on the island. Marina had spent her spring break visiting Puerto Rico with her parents as a show of support for her relatives. In her portion of the presentation, Marina presented photos and personal stories of overcoming hardships. During the other presentations, students began to call the disaster “Hurricane Marina,” before self-correcting
themselves. Student topical essays were generally well-researched and well-written. Their personal essays included suggested actions for the class, such as arranging an Alternative Break Immersion service trip through LUC Campus Ministry to Puerto Rico; contributing to Operation Blue Roof, which is run by the U.S. Army Corp of Engineers ($11 for a 16’ x 20’ tarp that would cover a damaged roof); purchasing $10 solar lanterns; and purchasing $30 water filtering systems. The majority of students are good public speakers. As shown in Table 1, Student Outcome thresholds were met for all five performance indicators: 95%, 90%, 100%, 95%, and 90%, respectively.

Beginning in Spring (late April), 2019, the social justice joint case study will also be assessed for student engagement and engineering persistence. Emulating patient monitoring curricular thread assessment, pre- and post-surveys, which include the Engineering Professional Responsibility Assessment (EPRA) Instrument [56], will be administered to class of 2021 sophomores. Pre-/post-survey results will be tied to AWE survey results.

Assessment of the joint case study is tied to the Director’s work with the new International Association of Jesuit Engineering Schools (IAJES), which has 44 member schools and programs. As chair of the task force for an engineering and social justice case study repository, she is expanding the joint case study format to a general framework of technology vs. citizen rights that will enable engineering deans and directors at other Jesuit universities to construct case studies for their students. Two IAJES engineering schools are constructing their own joint case studies, while LUC’s Spring 2019 joint case study is evaluated. Together, they will present their findings at the Summer, 2019 IAJES conference, which will lay the foundation for a new social justice case study repository.

Faculty Diversity

Faculty hiring practices have led to a diverse faculty, in terms of gender, ethnicity, and industry experience:

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Gender</th>
<th>Ethnicity</th>
<th># Yrs Industry Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gail Baura</td>
<td>Director &amp; Prof.</td>
<td>F</td>
<td>Asian-American</td>
<td>16</td>
</tr>
<tr>
<td>Chad Johnston</td>
<td>Asst. Prof.</td>
<td>M</td>
<td>White</td>
<td>0</td>
</tr>
<tr>
<td>Gajan Sivandran</td>
<td>Clin. Asst. Prof.</td>
<td>M</td>
<td>Asian-Australian</td>
<td>4</td>
</tr>
<tr>
<td>Vincent C.F. Chen</td>
<td>Asst. Prof.</td>
<td>M</td>
<td>Asian</td>
<td>6</td>
</tr>
<tr>
<td>Jason Streeter</td>
<td>Clin. Asst. Prof.</td>
<td>M</td>
<td>White</td>
<td>10</td>
</tr>
<tr>
<td>Brook Abegaz</td>
<td>Asst. Prof.</td>
<td>M</td>
<td>African</td>
<td>0</td>
</tr>
<tr>
<td>Sarah Ali</td>
<td>Clin. Asst. Prof.</td>
<td>F</td>
<td>Middle-Eastern</td>
<td>4</td>
</tr>
</tbody>
</table>

While the faculty sample size is small, Engineering Science faculty diversity compares favorably with 2017 ASEE statistics of percentage women and minority faculty in the U.S. [57]:
Table 3. Engineering Science Faculty Diversity Comparison To 2017 ASEE Diversity Statistics [57] and Fall 2017 Institutional Statistics [58].

<table>
<thead>
<tr>
<th>Group</th>
<th>2017 ASEE</th>
<th>LUC Engineering Science (n=7)</th>
<th>LUC All Faculty (n=1647)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>17%</td>
<td>28%</td>
<td>50.1%</td>
</tr>
<tr>
<td>African-American</td>
<td>3.1%</td>
<td>14%</td>
<td>5.9%</td>
</tr>
<tr>
<td>Asian</td>
<td>26.0%</td>
<td>43%</td>
<td>6.3%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>5.1%</td>
<td>0%</td>
<td>4.4%</td>
</tr>
</tbody>
</table>

In Table 3, statistics are also given for all LUC faculty members (n=1647) [58], which demonstrates that LUC does not currently have a diverse faculty. In future faculty searches, the Director will continue to advertise faculty positions more inclusively through ads on the National Society of Black Engineers and Society of Hispanic Professional Engineers websites.

Future Work

Surveying Graduates

ABET no longer requires that the achievement of program educational objectives (PEOs) be assessed and continuously improved. However, Engineering Science plans to evaluate PEOs with our graduates and improve processes to achieve PEOs. Starting in Summer, 2020, when we have two classes of graduates, we will conduct biennial surveys with PEO questions. In these surveys, we will also ask graduates how our social justice curriculum has impacted their careers. Informally, in March, 2019, one of our ten graduating seniors stated to the Director that he would accept his offer at start-up New Eagle, over an offer at Accenture, because New Eagle would enable him to hone his technical skills and work on several projects, including one social justice project.

Increasing Student Diversity

Engineering Science’s student population across four classes (n=95) is 46% female. We attribute this to LUC’s undergraduate population (n=11,420) being 66% female [58], Engineering Science having a female Director, and Engineering Science offering an active learning curriculum. However, the ethnic diversity of Engineering Science’s student population does not match the diversity of the faculty or of Chicago. Our students are 54% White, 2% African American (AA), 12% Hispanic (H), and 31% Asian (A). In contrast, Chicago is 33% White, 30% AA, 29% H, and 6% A [59].

The lack of engineering student diversity in Chicago is unsurprising. The two existing engineering schools in this city are Illinois Institute of Technology (IIT), which is a private institution, and public University of Illinois at Chicago (UIC). Historically, these engineering schools did not increase student diversity. IIT is located in a predominantly AA part of Chicago, just south of downtown. When it began to actively recruit AA students in the 1970s, IIT looked for only qualified, but not also qualifiable, candidates. It intentionally excluded lower-level,
remedial courses for incoming students, so that IIT’s curriculum would not be judged less rigorous. UIC is located west of downtown, close to Hispanic neighborhoods. Although UIC’s College of Engineering opened with very liberal admissions policies in 1966, it began to see these policies as a disadvantage among its peers. Teaching was overemphasized over research, which led to engineering faculty members leaving for other schools. The main branch of University of Illinois had fiscal control of UIC, and gave little support to technical research initiatives at UIC.

Both engineering schools were reacting to the low quality of instruction in the Chicago Public School (CPS) system in the 1970s, which is still present. For current CPS students, the issue begins in the middle grades where only 24% of students pass an Algebra I course in 8th grade [61]. By delaying algebra until 9th grade or later, it is programmatically difficult and highly unlikely students will reach a precalculus course by 12th grade without significant external support. This is evidenced by only 25% of Chicago public high school students meeting mathematics standards covering algebra, geometry, and problem solving through 11th grade [61]. CPS is the United States’ third largest school district with 372,214 total students, 90% of whom are racial or ethnic minorities and 83% are from low income families [61]. The district lacks the resources to provide the necessary supports to improve learning outcomes for all its students.

At LUC, we require that students admitted into the Engineering Science program have completed precalculus, to encourage students to take Calculus I their first semester and graduate in four years. Before the first semester, each admitted student takes a proctored ALEKS math placement assessment [62], which steers the student into taking Calculus I, Precalculus II, or Precalculus I the first semester. Our precalculus requirement is an impediment to admission for students of color. We have started to apply for federal and foundation grants that will enable us to offer mathematics tutoring over four years to a local AA high school and a local H high school, as well as summer bridging programs to admitted freshmen.

Conclusion

Loyola University Chicago’s Engineering Science program began in August, 2015, organized according to several social justice initiatives for students and faculty. Our biomedical, computer, and environmental engineering specializations emphasize high quality medical device software for all patients, programmable systems for the smart grid, and water/wastewater treatment, respectively. All engineering courses are taught using a mandatory minimal lecture style, as active learning retains female students, students of color, low-income students, and first-generation college students. We have embedded four social justice case study projects in the curriculum, for students to analyze the impacts of various technologies on society and consider how their future work will affect others. A final fifth social justice case study project will be added during the fifth year of the program. Faculty hiring practices have led to a diverse faculty, in terms of gender, ethnicity, and industry experience.

Through assessment of our multi-semester patient monitoring curricular thread, we are investigating if this increases student engagement and engineering persistence. Through assessment of our social justice joint case study, we are investigating if this case study also increases student engagement and engineering persistence. Additionally, both projects have been used to assess ABET Student Outcomes (1) and (3).
As the program matures, we will survey graduates biennially to assess the achievement of PEOs and the impact of our social justice curriculum on their careers. Although our student population is diverse in terms of gender (46% female), we wish to enroll more students of color, who may not meet our precalculus requirement. We have started to apply for federal and foundation grants that will enable us to offer mathematics tutoring over four years in high schools, as well as summer bridging programs to admitted freshmen.

References:


[29] K. O'Reilly, "The Top 20 Coolest Schools: These schools are ahead of the curve when it comes to sustainability," Sierra Club, Oakland, CA 2017.


