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Empathy and Gender Inequity in Engineering Disciplines

Dr. Eddie L Jacobs, University of Memphis

Eddie L. Jacobs holds a B.S.E.E. (1986) and M.S.E.E. (1988) degree from the University of Arkansas, and a D.Sc. degree in Electro-physics from the George Washington University (2001). Dr. Jacobs is a licensed professional engineer in the state of Tennessee. Dr. Jacobs began teaching in 2006 after a 17 year career as a US Department of Defense researcher. He currently serves as the Undergraduate Coordinator for the Electrical and Computer Engineering Department of the University of Memphis. He is actively involved in curriculum development and in efforts to form the professional identity of students. He serves as the faculty sponsor for IEEE-HKN honor society and a faculty advisor for IEEE. He provides numerous research experiences for undergraduates, primarily in the fields of optics and imaging which are his major areas of research. Dr. Jacobs is fellow of SPIE and a senior member of IEEE.

Dr. Amy L de Jongh Curry, University of Memphis

Amy L. de Jongh Curry, PhD, is an Associate Professor in the Department of Biomedical Engineering at University of Memphis (UM) with secondary appointment in the Department of Electrical & Computer Engineering. She also holds an adjunct position in the Department of Orthopaedic Surgery and Biomedical Engineering at University of Tennessee Health Science Center (UTHSC) through the Joint Graduate Program in Biomedical Engineering at UM/UTHSC. Dr. Curry received B.S. and M.S. degrees in electrical engineering and Ph.D. in biomedical engineering from the University of Memphis.

Her current research interests include cardiac and neural electrophysiology with applications in cardio- and neuro-modulation via implantable electrostimulation devices, computational modeling and visualization, and best practices in undergraduate engineering education. These efforts have been funded by the National Institutes of Health, National Science Foundation, and American Heart Association. Dr. Curry is a member of Tau Beta Pi, American Society for Engineering Education, Society of Women Engineers, and a Senior Member of IEEE Engineering in Medicine and Biology Society.

Dr. Russell J. Deaton, University of Memphis

Dr. Russell Deaton is currently Kanuri Professor of Engineering and Department Chair of Electrical and Computer Engineering at the University of Memphis. He is also Interim Associate Dean for Academic Affairs and Administration in the Herff College of Engineering. From 2000-2012, he was a professor in the Computer Science and Computer Engineering Department of the University of Arkansas, and from 1992-2000, was on faculty in the Electrical and Computer Engineering Department of the University of Memphis. He has a Ph.D. and M.S. in Electrical Engineering from Duke University, a B.S. in Electrical Engineering from the University of Memphis, and a B.A. in English from the University of North Carolina. In addition, he held engineering positions at UTC-Mostek and General Electric. He has published extensively in the area of DNA Computing and Molecular Programming, including DNA-guided self-assembly of nanostructures. He was organizing and program chair for 15th International Conference for DNA Computing and Molecular Programming (DNA15), and co-editor of a Springer volume of Lecture Notes in Computer Science with selected conference papers.

Dr. Carmen Astorne-Figari, University of Memphis

Assistant Professor of Economics, Fogelman College of Business and Economics, University of Memphis

Dr. Douglas Clark Strohmer, University of Memphis

Dr. Strohmer is former Chair of the Department of Counseling, Educational Psychology and Research. He holds fellow status in the American Psychological Association. His interests include: clinical judgment and decision-making, medical decision-making and the Internet, personality assessment, counseling process, professional identity, men in counseling, and disability issues. He has published over 70 articles in major counseling and psychology journals. In addition, he had authored several commercially available

assessment instruments for use with lower intelligence individuals. He has been awarded the American Rehabilitation Counseling Association (ARCA) research award three times, the National Council on Rehabilitation Education (NCRE) research and career educator awardS, the ARCA career research award, and the Pfizer Excellence in Research Award. Dr. Strohmer's work has also been recognized in other areas of counseling. For example, Dr. Strohmer was in the top 20 of individuals publishing in Journal of Counseling Psychology over a 25-year period. He has co-edited three journals (Rehabilitation Education, Assessment in Rehabilitation and Exceptionality, and The Journal of Forensic Vocational Assessment) and is current editor of the Rehabilitation Counseling Bulletin. He also served as team leader for the University of Memphis Professional Identity Research Team, which investigated the interplay between professional identity and work environment in the area of rehabilitation counseling.

Empathy and Gender Inequity in Engineering Disciplines

Eddie L. Jacobs *[1], Amy L. DeJongh Curry[2], Russell Deaton[1], Carmen Astorne-Figari[3] and Douglas Clark Strohmer [4]

[1]Department of Electrical and Computer Engineering, The University of Memphis
[2]Department of Biomedical Engineering, The University of Memphis
[3]Department of Economics, The University of Memphis
[4]Department of Counseling, Educational Psychology, and Research, The University of Memphis

Abstract

Based on analysis of published studies, we posit that the current owned identity of many engineering disciplines lacks empathy as a core element and that this may be a barrier to entry for women, especially in disciplines that are perceived as having little concern for the welfare of others. Moreover, as a consequence of this lack of empathy, the actual identity of engineering as embodied in faculty and academic programs may be in conflict with those human-centered values expressed by it's professional organizations. Therefore, to increase enrollment of women in engineering programs, a reformulation of the engineering identity to consciously incorporate empathy may be required. Our overall research efforts will be centered on first characterizing the empathetic aspects of this owned identity within some of the sub-disciplines of engineering, identifying the degree to which a perceived lack of empathy forms a barrier for women pursuing engineering as a field of study, and finally to formulate ways of transforming faculty and student attitudes in ways that will lead to the formation of an engineering identity that is more open to the concerns of women and more consistent with the values defined in the professional codes and creeds. This paper reports on our progress to date and our plans for future studies.

Introduction

A core principle of the National Society of Professional Engineers (NSPE) holds that the knowledge and skills possessed by an engineer are to be used to the advancement and benefit of human welfare[1]. The Institute for Electrical and Electronic Engineers (IEEE) has adopted the mission of fostering "technological innovation and excellence for the benefit of humanity"[2]. Most engineering programs concentrate on the development of knowledge and skills, with little emphasis on how those skills will be applied to benefit humanity. Some critics of the codes and

*eljacobs@memphis..edu

creedal statements of engineering's professional societies have even suggested the removal of these statements altogether[3] as they are deemed unnecessary to the definition of professionalism. By way of comparison, nursing education also spends a great deal of time teaching knowledge and skills, but does so while maintaining empathetic focus on the benefit and welfare of patients. Empathy can be defined as an ability to identify on an emotional level with another person, group, or society as a whole, coupled with a desire to help them. The concept of empathy is often studied as a factor in professional identities. In nursing, as in most of the helping professions, the role of empathy is deemed essential to the professional identity. Nursing is primarily a female dominated profession. Engineering is primarily a male dominated profession, and an examination of the motivations and attitudes of engineering students finds that the benefit to mankind is often perceived as largely absent from consideration[4]. Motivated by these observations, we posit that the current owned identity of engineers lacks empathy as a core element and that this may be a barrier to entry for women, especially in disciplines of engineering that are perceived as having little concern for the welfare of others. Moreover, as a consequence of this lack of empathy, the actual identity of engineering as embodied in faculty and academic programs may be in conflict with those human-centered values expressed by it's professional organizations. Therefore, to increase enrollment of women in engineering programs, a reformulation of the engineering identity to consciously incorporate empathy may be required. Our plan of research to investigate empathy as a factor in the participation of women in engineering will begin by first characterizing the empathetic aspects of this owned identity within some of the sub-disciplines of engineering. We will then seek to quantify the degree to which a perceived lack of empathy forms a barrier for women pursuing engineering as a field of study. Finally, we will attempt to formulate ways of transforming faculty and student attitudes in ways that will lead to the formation of an engineering identity that is more open to the concerns of women and more consistent with the values defined in the professional codes and creeds. In short, we will attempt to make students and faculty more empathetic.

In this paper, we give some justification for our claims and a brief description of our plans to achieve the goals described above. First, we give a review of the literature on the relationship between empathy and choice of profession for women. Second we describe the role empathy may play in the choice of engineering professions and how that role may be quantified. We then discuss how empathy may be taught to people who either by nature or by training are less inclined to be empathetic. Finally, we draw some conclusions regarding the potential impacts of this research.

Literature Review

In dealing with the problem of the underrepresentation of women in engineering, many have sought to eliminate the structural/institutional barriers to women in hopes of increasing involvement. Most of these barriers have been formulated in terms of bias and inadvertent (or overt) sexism inherent in the educational departments involved. Fox[5] found that while most institutions believe this problem stems from structural issues, their efforts to remedy the situation often devolve into efforts by individual or a few faculty members. They state "Such an individual orientation may be among the underlying factors that explain why many organizational efforts to

recruit and retain women fail to result in substantial gains for women." Reasons for this discrepancy between the defined problem and the attempted solutions are the high faculty control and low institutional surveillance of research-intensive engineering programs and the gendered environment of most engineering departments. This research clearly suggests that greater faculty involvement has seldom been applied to the problem of underrepresentation and is possibly a key to a successful remedy.

Assuming that greater faculty involvement in addressing the problem of representation is desired, the question then becomes what the faculty should do to increase the number of women in engineering. The following papers suggest that the answer may lie in the identity of engineers. Godwin et. al.[6] studied the effect of students' identities in physics, mathematics, and general science on their engineering identity and to what extent an engineering identity is predictive of the choice of engineering as a college major. They used an open-ended hypothesis-generation survey that sought to measure the participants' beliefs in their performance/competence for the three subjects. Performance/competence is an individual's beliefs in their ability to perform effectively academically and the competence or understanding of engineering concepts. By measuring these traits in engineering and non-engineering students, they were able to form indices in identities in physics, math, and science that predict the index of engineering identity. They were also able to show the degree to which an engineering identity predicts the choice of engineering as a major. This study emphasizes the traditional engineering identity concentrating on performance/competence in math, physics, and science. However, in a similar type of study, Matusovich et. al.[7] has studied the motivations of engineering students using techniques based on Eccles' expectancy-value theory[8]. This theory hypothesizes that competence beliefs (CAN I earn an engineering degree?) coupled with task value beliefs (Do I WANT to earn an engineering degree?) combine to form motivated goals and actions that determine whether or not a person succeeds in engineering. They modified Eccles definitions of value codes assigned to Attainment, Cost, Interest, and Utility to pertain specifically to engineers. They then assess these values using questions conducted in individual interviews and group questionnaires. They observe "more women than men participants experienced a lack of connection between their engineering-related values and sense of self (low attainment values)." The modified definition of attainment used in this study is stated as "A reason for pursuing (or not pursuing) engineering that is related to being the type of person who is an engineer." This study seems to indicate that women have difficulty connecting with the current owned identity of engineers and supports the idea that this identity may be at the heart of the issue. Benson et. al.[9,4] have also studied student motivations to pursue engineering as a major using surveys and interviews. Part of this research was the development of the Motivations and Attitudes in Engineering (MAE) survey. This research differentiates traditional engineering majors (mechanical for this study) from interdisciplinary majors such as Bioengineering or Biomedical engineering. A key finding was that "Students who score highly on knowing an engineer as a reason for selecting a major, wanting a good potential salary, designing and building things, and their perceptions of the present were likely to be traditional engineers. Students who want to prove themselves in the hardest possible major and benefit society are likely to be in interdisciplinary majors." In addition, "BIOE (bioengineering) females feel they have a greater understanding and ethical responsibility, and confidence in their choice of major compared to top enrollment (traditional engineering and other majors) females." Rasoal, et. al.[10] performed a study on students in Nursing, Medicine, Social Work, Psychology, Applied Physics,

and Computer Engineering using a questionnaire based on the Interpersonal Reactivity Index (IRI)[11]. They measured four factors associated with the IRI and found that applied physics and computer engineering students were less empathetic on most measures. They subsequently derived corrections for sex based on the non-engineering majors and applied them to the results. They found that "Engineering students have significantly lower empathy than students from other programmes. However, when these differences were corrected for effects of sex, only a few significant differences remained, which indicates that sex has an effect on the development of empathy." This reference supports the idea that women have higher empathic response than men and it is an important part of their identity. It also supports the premise that the lack of empathy in engineering may be correlated with the male predominance of students in the major and among the faculty. Penprase et.al[12] examined the proposition that higher dispositions for empathy predispose male students to careers in nursing as opposed to other professions. To assess empathy they used the Empathizing and Systemizing Quotient (EQ-SQ) developed by Simon Baron-Cohen[13]. This instrument is based on the theory that empathizing and systemizing are fundamental ways in which people interact with the world. Empathizing (EQ) is identifying with the thoughts, emotions, and feelings of others. Systemizing (SQ) is analyzing, exploring, and constructing systems. Penprase' group found that nursing students (male and female together) had a mean EQ score of 51 while engineering students (male and female) had a mean EQ score of 40.17. Conversely, engineering students had a mean SQ score of 73.07 as opposed to 58.32 in nursing. Among nursing students alone, female students had a mean EQ score 51.9 while male students had a mean of 45.2. Female nursing students had a mean SQ of 57.2 while male nursing students had a mean SQ score of 65.1. This reference strongly supports the idea that empathy is a key factor in choice of profession and a large factor separating engineering from nursing. Addressing the issue of empathy in faculty and practicing engineers, Strobel[14] conducted a qualitative study of how empathy and care look within the profession and academia. They conducted a literature review and used small group interviews with open-ended responses to some questions. Using these methods they then characterized the role of empathy as a human trait, as a professional state, as a communication process, as caring, and as a special relationship. Empathy as an innate human trait suggests it is capable of being refined. Empathy as a professional state identifies it as a way of being. Empathy as a communication process involves internalization of another's perspective, expressing empathy through communication, and that empathy being perceived by another. Empathy as caring describes empathy in terms of actions carried out by individuals or groups. Empathy as a special relationship defines it as a reciprocal relationship developed over time between two individuals when empathy is present, cultivated, and visible. Based on a thematic analysis of the results, empathy as a human trait was seen by faculty members to be inherent in certain acts such as participating in team projects. It's value as a state of being was that it provided greater opportunities for academic or professional success. It was valued as a communication process in that it enhances the ability to communicate, which is important in team activities and responding to clients. Empathy as caring was the way most of the participants in this study identified empathy in general, rather than identifying it with any emotion. Empathy as a special relationship was confined to either a relationship with "society" as a whole or to a utilitarian one-on-one relationship (how will empathy help another) devoid of emotional components. Finally, they recommend "a more holistic engineering profession which welcomes explicit recognition and promotion of empathy and care might provide a vehicle to attract different students to the field of engineering, increase the likelihood that broader audiences

perceive engineering as a relevant, inclusive, and impactful profession, and so increase and retain diversity within the student body."

The body of research on empathy and empathy in engineering surveyed above strongly supports the ideas that 1) empathy is an important factor for identity in women and 2) empathy is typically low among engineering students and faculty.

Empathy and Engineering Disciplines

Is empathy really a factor in women choosing engineering as a profession? In the following we provide further evidence that it is and discuss what research we believe is needed to thoroughly understand this issue.

In the process of reviewing the literature on empathy and engineering, we noted previously the use of the EQ-SQ score developed by Simon Baron-Cohen[13]. In an uncontrolled study, we asked students and acquaintances who were associated with the authors to take a publicly available online EQ-SQ exam[15] and voluntarily report their scores to us. The results we obtained are shown in Figure 1. We were also able to identify individuals in this group who had an engineering related background meaning that they either had a job that was engineering related or were pursuing or desiring to pursue such studies if they were secondary school or college students. There were a mix of ages ranging between high school students and professors in mid-carreer. We would expect based on the published literature that men would generally have higher SQ than EQ scores and that people with higher SQ scores would be in engineering related areas. The results do seem to bear out these claims though this is by no means a definitive study.

If empathy is a factor in the choice of profession for women, then it stands to reason that engineering disciplines that are by nature more concerned with the welfare of individuals or society (more empathetic) would have greater numbers of women in them. Data compiled for the number of bachelors degrees awarded to women by the ASEE in five major engineering disciplines is shown in Table 1. If one accepts that Biomedical and Civil engineering are more directly concerned with the welfare of individuals and society than Computer, Electrical, or Mechanical Engineering, then the numbers seem to be in agreement with intuition. Admittedly, there are some disciplines reported in the ASEE data that have high participation of women that do not intuitively have a deep concern for individuals or communities. Chemical, Industrial, and Materials Engineering all have relatively high percentages of women graduates but do not intuitively seem to be empathetic endeavors. The case could be made that many Chemical, Industrial, and Materials engineers often end up in biomedical or environmental professions but we have no data to support that conjecture. Regardless, intuition seems to be correct for most disciplines. Environmental Engineering has near gender parity with 48 percent of the graduates in 2014 being women.

The data presented is suggestive but inconclusive. Much further study is needed. We are currently formulating a survey instrument to measure the perceived empathy of various engineering and non-engineering related disciplines as well as perceptions toward pursuing or practicing the profession. We intend to administer this survey to several groups including college and high school students as well as faculty members and practicing engineering professionals. From this

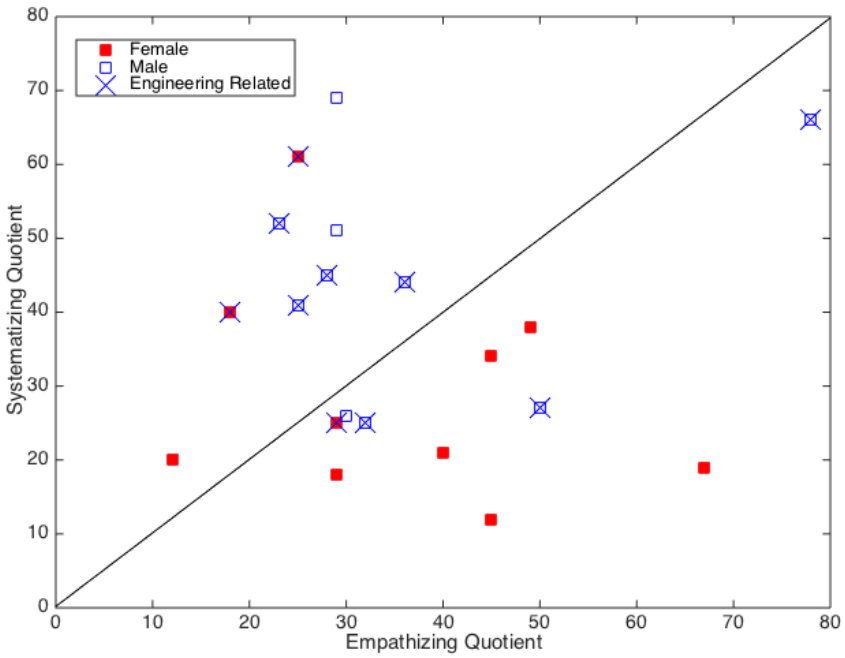

Figure 1: EQ-SQ score data collected for students and acquaintances.

Discipline	2009	2010	2011	2012	2014
Biomedical	36.9	37	39.1	39.2	40.6
Civil	20.1	20.3	21	20.6	19.4
Computer	7.9	9.5	9.4	8.5	12.0
Electrical	11.5	11.6	11.5	12.7	13.7
Mechanical	11.4	11.5	11.7	12.4	13.5

Table 1: Percentage of bachelors degrees awarded to women in selected engineering disciplines by year.[16,17,18,19,20]

data we hope to better understand the perceived empathy of various engineering disciplines from various points of view ranging from those who are and are not considering engineering as a profession to those who are pursuing engineering as a profession and those who are practicing engineering as a profession. We also intend to use this instrument to quantify changes in perception. In our surveys of high school students, some will receive the instrument directly and others will be given case studies or stories in which various engineering disciplines are engaged in empathetic endeavors prior to taking the survey. From this data, the effect of exposure to examples of empathetic engineering activities will be quantified. This study will be conducted over the next year and results will be reported in future publications.

Engineering Empathy

If we accept that empathy is a factor in women's choice of engineering in general and particular disciplines, it follows that if perceptions of disciplines that are viewed as less empathetic are changed, then participation may change. Of course, just changing a perception without changing the underlying behaviors would have no lasting benefit. So how do programs and individuals that have traditionally been un-empathetic learn empathy? Can empathy even be learned?

A surprising proof that empathy is learned is given in the recent well publicized work of Erin Cech at Rice University[21]. In her article "Culture of Disengagement in Engineering Education" she provides compelling evidence that many engineering programs produce graduates that are less empathetic than when they entered. A similar trend has been noticed in the training of medical students[22]. In essence, we teach them to be un-empathetic. If we can teach them to be un-empathetic, can we teach them to be more empathetic? Such programs have been implemented in the training of medical students have demonstrated a measurable increase of empathy of the participants[23].

The need for empathy training in engineering has begun to be recognized and some programs are attempting to inject empathetic training into their curricula[24]. The well known professional firm IDEO has even inculcated empathy as part of their business model[25]. What is not known, and what we are specifically addressing is the impact these efforts will have on attracting and retaining women into engineering disciplines in which they are traditionally poorly represented. From this point of view, the Walther effort at the University of Georgia cited previously may be of limited value as it is being applied to Environmental Engineering which, as was previously mentioned, has near gender parity nationally. Nevertheless, their educational methods may be broadly applicable.

Taking a cue from training in empathy given to social workers[26], a key element in teaching empathy is experiential learning. Students learn empathy by engaging in activities that allow them to feel what others may feel. Examples would be spending time in a wheel chair or on crutches in order to understand (develop empathy) for those who need these assistive devices on a temporary or permanent basis. Another activity may be navigating from a poor neighborhood of a community to a work center using only public transportation options in order to understand the plight of individuals whose sole means of transportation is the public transportation system. What are good experiential learning activities that could be incorporated into computer, electrical, or

mechanical engineering programs? Our research will seek to identify examples of these activities and measure their effect on empathy within these sub-disciplines.

Discussion and Future Plans

The hypotheses we wish to test are that 1) a perceived lack of empathy is a barrier to women entering engineering, the strength of that barrier varying by discipline with respect to the perception of empathy and 2) that this perception and participation can be improved by intentionally incorporating empathy into those disciplines. We are currently formulating the survey instrument we think will give us the best way to assess the current perceptions of individuals. We also anticipate using this instrument in the assessment of any interventions we may apply. To that end we are also formulating ways to incorporate empathy into our recruitment, the classroom experience, and undergraduate research efforts at our university.

The broader impacts of this research are threefold. The first and most obvious impact is that this research could point the way to increasing the representation of women in fields such as electrical, computer, and mechanical engineering. By quantifying the role that empathy plays in the identity of potential engineering students and formulating methods to increase focus on empathetic activities as a part of the engineering education process, women may find a greater affinity for disciplines that have traditionally suffered from under-representation. A second impact of this research is the potential impact on engineering students as a whole. ALL students could benefit from an increased emphasis, exposure, and experience with empathetic endeavors. Even if a student's career path leads to one of the traditional industries associated with electrical, computer, or mechanical engineering, activities such as working in teams, managing the efforts of others, and identifying with consumers of products are all enhanced through skills in empathy. The final impact is that experienced by the profession and society as a whole. A shift in focus toward more empathetic endeavors will bring greater resonance between the training a student receives and the objectives outlined in the professional identity statements of the major engineering societies. We may have an opportunity in this research to empower young engineers to actually do what we encourage them to do in every graduation speech: make the world better. By gaining experience in empathetic endeavors as students, they may be more prone to seek opportunities to do so as part of their professional careers or personal lives. The impact to society would be in lives saved, bettered, and inspired. As Kate Canales of Southern Methodist University has put it, "Empathy can make you a more innovative _____." where the blank can be anything[27]. These points were echoed recently by Lina Nilsson, director of the Blum Center for Developing Economies at the University of California Berkeley[28]. In an Op-Ed in the New York Times entitled "How to Attract Female Engineers," she states "the key to increasing the number of female engineers may not just be mentorship programs or child care centers, although those are important. It may be about reframing the goals of engineering research and curriculums to be more relevant to societal needs. It is not just about gender equity — it is about doing better engineering for us all."

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